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FIG. 2.—TESTING THE TENSILE STRENGTH OF FABRICS FOR THE ENVELOP OF THE PNEUMATIC TIRE.

FIG. 8.—TESTING AIR-CHAMBERS UNDER WATER.

FIG. 1.—OBJECTS FOUND IN MASSES OF INDIA RUBBER.

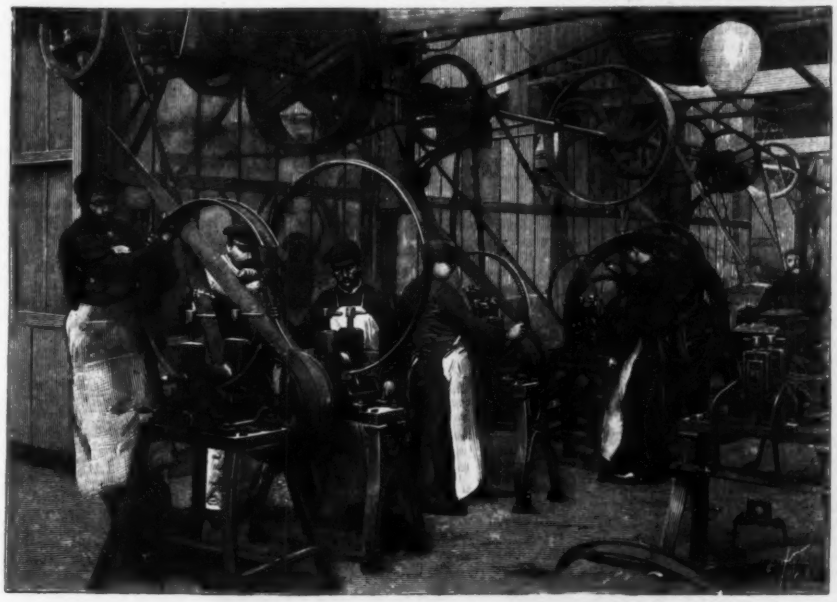


FIG. 3.—OPERATION OF CURVING RIMS.

FIG. 7.—THE STOVE FOR HEATING ENVELOPS AND AIR-CHAMBERS.

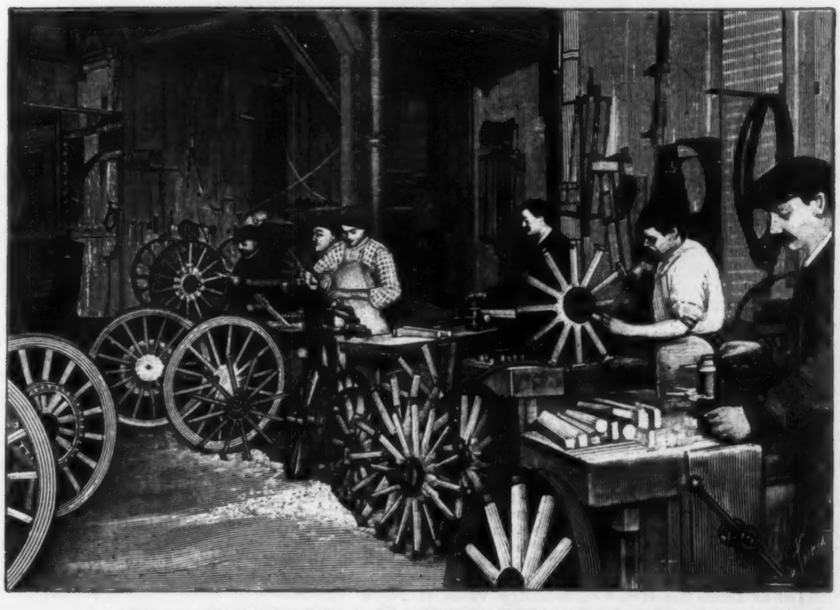


FIG. 4.—MANUFACTURE OF WHEELS FOR AUTOMOBILES.

THE MANUFACTURE OF A PNEUMATIC TIRE.

THE great progress made by those instruments of road locomotion, the bicycle and the automile, is due in a very large measure to the pneumatic cushions or tires upon which they roll. We say in a very large measure, since there is no doubt that but for them the most ingenious improvements in mechanism would have counted for nothing. Vibrations and shocks constituted an absolutely insurmountable barrier to the bicycle and automobile when they attempted to exceed the headway of 18 miles an hour. The records of the bicycle for twelve years and those of the automobile for five, and the tests that may be daily made demonstrate that the fortune of our modern road vehicles is, without a shadow of a doubt, closely dependent upon the character of the surfaces upon which they roll.

It seems, therefore, that at a time when the approach of spring and the Universal Exposition is about to render the infatuation for "locomotion" more evident than ever before, a study of that interesting device, the pneumatic tire, may prove of genuine interest.

The pneumatic tire consists of three elements, viz.: (1) an endless rubber tube called the "chamber," in which air is compressed by means of a pump; (2) an envelop composed of canvas provided with a coating of rubber, which prevents abnormal expansion of the chamber and the bursting thereof, and protects it against objects that might lacerate it; and (3) a felly, or rim of steel, provided with a groove in which the tire is secured by flanges and held in place by the pressure of the chamber that it incloses.

The three constituent materials of a pneumatic tire are, therefore, india rubber, canvas, and steel. Of the two latter we shall have but a few words to say. The fabric that enters into the formation of the envelop is very carefully selected unbleached cotton cloth. One of the accompanying cuts (Fig. 2) shows the operation of testing the fabric in order to ascertain its tensile strength. The fabric, in order that it may be used, must have been previously submitted to a "gumming" process. To this effect it is passed slowly over a cylinder, beneath a straight-edge that serves as a barrier to a thick solution of rubber. Then it is spread out upon a heated table, where, as the benzine of the solution evaporates, the coating of rubber dries upon its surface. The operation is sometimes performed upon both sides of the fabric. Further on we shall see what is the exact rôle of the canvas thus prepared.

The rim, which is made of fine and rather tough steel, is formed by passing a flat plate through a drawing roller, and then through a machine (Fig. 3) that gives it the section necessary to allow the tire to be secured to it. The hoop thus formed is then closed, riveted and brazed, and finally calibered, since a very slight variation in its diameter would have the result, either of rendering the mounting of the envelop impossible if it were too wide, or of rendering the securing of it imperfect if it were too small, or, in other words, of subjecting the chamber to the danger of bursting at any moment.

India rubber, which, upon the whole, is the main constituent material of the pneumatic tire, since the two other materials serve merely as a support for it, is a very interesting substance. The manufacture of it is of a most complex and difficult character, and accompanied with numerous "wrinkles." We have the pleasure of stating that in this industry France maintains a marked superiority over other nations. The works that the MM. Michelin have built at Clermont-Ferrand for its manufacture (the principal stages of which are represented in the accompanying engravings) are a model of their kind, and are gradually discarding empirical methods in favor of scientific processes. A laboratory of chemists, a shop for testers, and tracks and special carriages for experiments are adjuncts to this village of the pneumatic wheel.

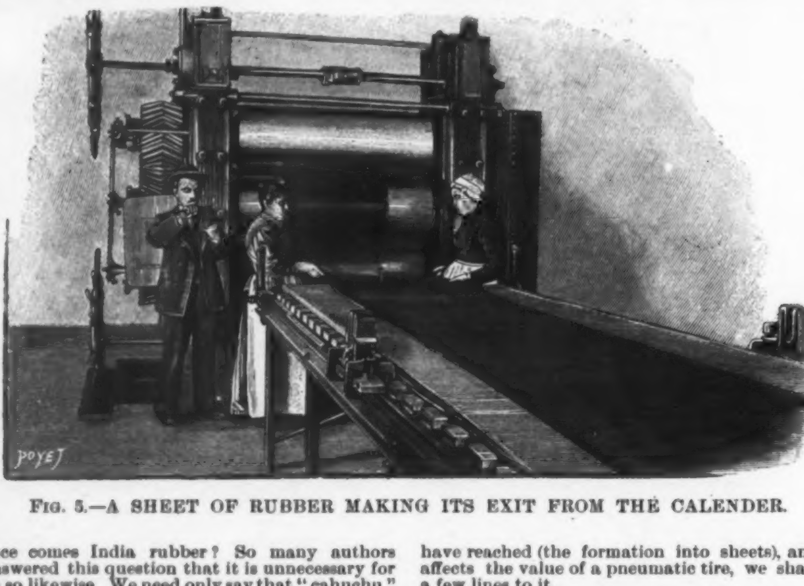


FIG. 5.—A SHEET OF RUBBER MAKING ITS EXIT FROM THE CALENDER.

Whence comes India rubber? So many authors have answered this question that it is unnecessary for us to do so likewise. We need only say that "cahuchu" or "tree-juice" is a liquid, a white and saccharine latex which flows from certain vines and trees of South America, Africa, and Asia when an incision is made in them, and which the natives coagulate either through heat or the acid juice of the fruit of the urucuri-palm. Let us add here that these same natives, in order to increase the weight of the balls thus formed, often coagulate the latex around a stone, a large shell, a piece of wood, or an arrowhead. Cheating in weight is common to all lands.

Let us recall the fact, too, that the value of India rubber depends much upon its place of origin. The Para variety, which comes from the forest of the Amazons, is worth, on an average, at Havre, about twelve francs per kilogramme, while the African gums are worth but eight francs or thereabout.

From whatever source it is derived, however, the substance is treated by the same processes. The balls or blocks are cut into large pieces, which are thrown into tubs of tepid water, where they become soft. After this they pass into an apparatus formed of two cylinders having rough surfaces, which roll against each other with different velocities and crush them into smaller and smaller fragments. This first operation, which is always performed under a current of water, frees the rubber of the débris of wood and of the earth, sand, and what not that the natives have designedly or otherwise incorporated with it (Fig. 1).

Reduced to strings composed of pieces of about the size of a thimble, the rubber is then thrown into tubs of tepid water where it becomes further softened. The softening in fact, is very necessary, in order that, after being freed from its impurities, it may be formed into a mass for rolling.

FIG. 6.—OPERATION OF CEMENTING CANVAS AND RUBBER UPON THE FORM.

The material is next passed between two smooth cylinders, which crush it and convert it into wide plates. These latter, after being again rolled, are joined end to end so as to form a coarse, grained ribbon of about a tenth of an inch in thickness and about 60 feet in length.

This forming of the material into ribbons does not modify its quantities or the defects that it possesses in the raw state. It remains pliable and elastic, but the mere heat of the sun renders it sticky, and the least frost makes it brittle. Vulcanization, or the incorporation of sulphur with the rubber through the aid of heat—a process devised by Mr. Chas. Goodyear, of New York, in 1840, converts it into an entirely new substance. The chemical phenomena of vulcanization have not, as yet, been fully explained. All that we know is that the incorporation of from 4 to 10 per cent. of sulphur not only permits the rubber to preserve its native qualities of elasticity, but amplifies them in giving the material the strength that it lacked and in depriving it of its sensitiveness to cold and heat.

This addition of sulphur was, unfortunately, to put adulterators upon the track of other and much less advantageous additions. As the adulterating of rubber is always done at the stage of manufacture that we have reached (the formation into sheets), and greatly affects the value of a pneumatic tire, we shall devote a few lines to it.

It is possible greatly to vary the number and proportions of the elements that constitute 25 kilogrammes of pure, and the same weight of adulterated rubber. The rich mixture is composed of 24·25 kilogrammes of Para rubber at 15·75 francs per kilogramme, and 0·75 of pure sulphur at 0·22 franc per kilogramme, say a net cost of 14·45 francs per kilogramme. The weighted mixture is composed of 4·75 kilogrammes of African rubber at 12 francs, 0·75 kilogramme of flowers of sulphur at 0·22 franc, 7 kilogrammes of linseed oil and sulphur at 0·65 franc, 7 kilogrammes of whiting at 0·04 franc, 5 kilogrammes of zinc white at 0·65 franc, and 0·5 kilogramme of waste rubber at 2·5 francs, say a net cost of 2·65 francs per kilogramme. The density of the rich mixture is 0·5, and that of the weighted 1·6. The result is that a cubic decimeter of the first mixture costs in material 15 francs, while the same bulk of the second costs but 1·65 franc.

The chemical difference of the two mixtures does not seem to be very different. The second, however, is deficient in the essential and somewhat mysterious qualities of pure India rubber, which are resiliency, homogeneity, and elasticity. It will be understood that anything, like a pneumatic tire, works by crushing and traction, and is submitted to shocks, cutting and flexing, must possess to a maximum degree the resistance of the Para mixture and something more than the inertia of the factitious substance that is employed for gas pipes and articles sold in bazaars.

Let us now return to our sheets of rubber. The ribbons obtained through the crushing of the raw gum are very coarse. It is now the duty of the workman who receives them, first to form the material to be vulcanized, and then to convert this material into a thoroughly homogeneous substance. Such transformation is effected between the cylinders of an apparatus called the mixing machine, the base of which is provided with a trough in which the sheets are deposited. The workman secures the sheet between cylinders and dusts it with sulphur, and then takes it out and cuts it and kneads it, and then secures it in the cylinders again, and so on until he judges that the mixture is perfect.

The work is then finished in the calender, an apparatus consisting of hollow, steam-heated cylinders. Upon coming, from these, the sheet of rubber, charged with sulphur, is as smooth and even as sheet iron. Fig 5 shows the examiner inspecting a piece of the rubber in order to see whether the sheet is exactly of the thickness necessary.

The sheet as it comes from the calender is the material from which are cut the pieces necessary for the manufacture of pneumatic tires. The rubber is not yet vulcanized, since it has not been submitted to the action of heat. It is simply mixed with sulphur and some special powders in the proportions desired, and remains sufficiently plastic to retain any shape that may be given to it.

In order to make an envelop, the workman passes around a circular bronze form (Fig. 6) a band of the gummed canvas that we have already mentioned, and cements the two ends together. This first band is wider than the form, since the workman is to place in its upturned edges the lateral projections of very hard rubber that serve to hold the envelop in the groove of the rim. He next glues in succession upon this backing a band of rubber and a band of canvas, and finishes with a band of rubber called a "crescent," and which is thicker in the middle than at the edges. Pneumatic tires for carriages have four thicknesses of fabric.

In order to subject the envelop to heat, the workman places the bronze form between two steel shells which inclose it hermetically. The envelops, piled one on top of the other, are then squeezed together in a hydraulic press and carried to a steam-stove, where they are submitted to heat (Fig. 7). The envelop, upon its exit, appears as if made in one piece, and the fusion of the rubber gives it the aspect of having been produced by a single molding.

The manufacture of the air chamber is effected differently. The sheet of rubber engages with the screw of a drawing-machine, which kneads it and discharges it, through a round aperture, in the form of a seamless tube. It is afterward placed upon a rod and covered with canvas to prevent its distortion, and surrounded with talc and placed in a steam-stove. Upon making its exit from the latter, it is tested (Fig. 8). To this effect a female operative inflates the tube sufficiently to form a slight bulge at one of its points, and places it under water. Then, by means of her two hands, she causes this protuberance to move all along the tube. If any leakage, even a very slight one, exists, a bubble of air upon the water will at once reveal it. In case a leak should exist, the tube is placed in the refuse heap. Should it on the contrary, prove perfect, it is closed, that is to say, its two extremities are cemented together by means of a solution of rubber in benzine. The valve that is to be used to inflate it is afterward inserted in an aperture that a female operative has formed for its reception.

After the chamber has been found to be perfect, it is mounted upon the felly and covered with its envelop. The pneumatic tire thus complete is inflated and carried to a special store room, where it remains under inspection for two months; after which it is put upon the market.

Such are, in a few words, the principal phases of the manufacture of those air cushions which, blown to 6

and 7 atmospheres, resist, for 5,000 and 6,000 kilometers, the incalculable work demanded by 1,200-kilogramme carriages that cover 40 and 50 kilometers an hour. It is a wide difference that separates such tires from the small English tubes of ten years ago that made bicyclists desperate by the deplorable facility with which they gave up the ghost!

As we said at the beginning of this article, the fate of automobilism is closely connected with the character of the pneumatic tire, since the latter is the yielding and ever resilient rail upon which the carriage rolls. For the foregoing particulars and the illustrations, we are indebted to La Nature.

MODERN EXPLOSIVES.*

THE subject of explosives is one which never fails to excite interest even under the most ordinary conditions, doubtless owing to the enormous potentiality of these substances, while at the present time more than usual attention is directed to them, it being scarcely possible to read a daily paper without finding some reference to the behavior of various modern explosives in the theater of war.

Explosion may be defined as chemical action causing extremely rapid formation of a very great volume of highly expanded gas, this large volume of gas being generally due to the direct liberation by chemical action, and the further enormous expansion by the heat generated. Explosion itself may, therefore, be regarded as extremely rapid combustion, while the effect is obtained by the enormous pressure produced owing to the products of combustion occupying probably many thousand times the volume of the original body. The effect of high temperature is seen in the well-known case of explosion of a mixture of hydrogen and oxygen, where if the original mixture and the products of explosion are each measured at the same temperature above the boiling point of water, a less volume of gas (water vapor) is actually found. The explosion can only have been produced by the enormous expansion of this vapor in the first place by the heat of the reaction. Such an explosion when carried out in a closed bomb with the mixed gases under ordinary conditions of measurement produces a pressure of about 240 pounds to the square inch. A more practical illustration is seen with nitroglycerine, which Nobel found yielded about 1,200 times its own volume of gas calculated at ordinary temperatures and pressures, while the heat liberated expands the gas to nearly eight times this volume.

Clearly, then, a substance for use as an explosive must be capable of undergoing rapid decomposition or combination with the production of large volumes of gas, and further produce sufficient heat to greatly expand these gases; the ratio of the volume of gases at the moment of explosion to the volume of the original body largely determining the efficiency of the explosive.

Explosives may be divided into two great classes—mechanical mixtures and chemical compounds. In the former the combustible substances are intimately mixed with some oxygen supplying material, as in the case of gunpowder, where carbon and sulphur are intimately mixed with potassium nitrate; while guncotton and nitroglycerine are examples of the latter class, where each molecule of the substance contains the necessary oxygen for the oxidation of the carbon and hydrogen present, the oxygen being in feeble combination with nitrogen. Many explosives are, however, mechanical mixtures of compounds which are themselves explosive, e. g., cordite, which is mainly composed of guncotton and nitroglycerine.

Two methods are in common use for bringing about explosions—ignition by heat, thus bringing about ordinary but rapid combustion, molecule after molecule undergoing decomposition; and detonation, where the effect is infinitely more rapid than in the first case; in fact, it may be regarded as practically instantaneous. The result may be looked upon as brought about by an initial shock imparted to the explosive by a substance—the detonating material—which is capable of starting decomposition in the adjacent layers of the explosive, thus causing a shock to the next layer, and so on with infinite rapidity. That the results are not entirely due to the mechanical energy of the liberated gas particles is shown by the fact that the most powerful explosive is not the most powerful detonator; neither is it entirely due to heat, since wet substances undergo detonation. The probability is that the result is brought about by vibrations of particular velocity which vary for different substances, the decomposition being caused by the conversion of the mechanical force into heat in the explosive, thus bringing about a change in the atomic arrangement of the molecule. According to Sir Frederick Abel's theory of detonation, the vibrations caused by the firing of the detonator are capable of setting up similar vibrations in the explosive, thus determining its almost instantaneous decomposition.

The most common and familiar of explosives is undoubtedly gunpowder, and although for military purposes it has been largely superseded by smokeless powders, yet it has played such an important part in the history of the world during the last few centuries that apart from military uses it is even now of sufficient importance to demand more than a passing notice.

Its origin, although somewhat obscure, was in all probability with the Chinese. Roger Bacon and Berthold Schwartz appear to have rediscovered it in the latter years of the thirteenth and earlier part of the fourteenth centuries. It was, undoubtedly, used at the battle of Crecy. The mixture then adopted appears to have consisted of equal parts of the three ingredients—sulphur, charcoal, and niter; but some time later the proportions, even now taken for all ordinary purposes, were introduced, namely:

Potassium nitrate	75 parts.
Charcoal	15 "
Sulphur	10 "
	100 parts.

Since gunpowder is a mechanical mixture, it is clear that the first aim of the maker must be to obtain perfect incorporation, and, necessarily, in order to obtain this, the materials must be in a very finely divided state. Moreover, in order that uniformity of effect may be obtained, purity of the original substances, the percentage of moisture present, and the density of the finished powder are of importance.

The weighed quantities of the ingredients are first mixed in gun metal or copper drums, having blades in the interior capable of working in the opposite direction to that in which the drum itself is traveling. After passing through a sieve, the mixture (green charge) is passed on to the incorporating mills, where it is thoroughly ground under heavy metal rollers, a small quantity of water being added to prevent dust and facilitating incorporation, and during this process the risk of explosion is greater possibly than at any other stage in the manufacture. There are usually six mills working in the same building, with partitions between. Over the bed of each mill is a horizontal board, the "flash board," which is connected with a tank of water overhead, the arrangement being such that the upsetting of one tank discharges the contents of the other tanks onto the corresponding mill beds below, so that in the event of an accident the charge is drowned in each case. The "mill cake" is now broken down between rollers, the "meal" produced being placed in strong oak boxes and subjected to hydraulic pressure, thus increasing its density and hardness, at the same time bringing the ingredients into more intimate contact. After once more breaking down the material (press cake) the powder only requires special treatment to adapt it for the various purposes for which it is intended.

Within the last half century an enormous alteration has taken place in artillery, the old smooth bore cannon, firing a round shot, having gradually given place to heavy rifled cannon, firing cylindrical projectiles and requiring very large powder charges. This has naturally had its influence on the powder used, and modifications have been introduced in two directions—first, alteration in the form of powder, and second, in the proportions of the ingredients. As the heavier guns were introduced, a large grain powder which burned more slowly was adopted, but further increase in the size of the guns led to the introduction of pebble powders, which in some cases consisted of cubes of over an inch side. Such cubes having large available surface evolved the usual gases in greater quantity at the start of the combustion than toward the finish, since the surface became gradually smaller, thus causing extra strain on the gun as the projectile was only just beginning to move. General Rodman, an American officer, introduced prism powder to overcome this difficulty, the charges being built up of perforated hexagonal prisms in which combustion started in the perforations and proceeding, exposed more surface, the prisms finally breaking down into what was virtually a pebble powder.

In order to secure still further control over the pressure, modifications in the proportions of the ingredients became necessary; the diminution of the sulphur and increase of the charcoal causing slower combustion, and moreover the use of charcoal prepared at a low temperature giving the so-called "cocoa powders."

The products of the combustion of powder and its manner of burning are largely influenced by the pressure, a property well illustrated by the failure of a red hot platinum wire to ignite a mass of powder in a vacuum, only a few grains actually in contact with the platinum undergoing combustion. The gaseous products obtained are carbon dioxide, carbon monoxide, and nitrogen, other products being potassium carbonate, sulphate, and sulphide. The calculated gas yield at 0° C. and 760 mm. pressure is 264·6 c.c., while Noble and Abel actually obtained by experiment 263·74 c.c., numbers agreeing very closely. At the temperature of explosion this volume is enormously increased.

In 1832, Braconnot found that starch, ligneous fiber, and similar substances when treated with strong nitric acid yielded exceeding combustible substances, and Pelouze, in 1838, extended the investigation to cotton and paper. Schönbein announced in 1845 his ability to make an explosive which he termed guncotton, and a year later Böttger made a similar announcement, and on a conference being held between these chemists their methods were found to be identical. The method was not disclosed at the time, since it was hoped that the German government would purchase the secret, but in a very short time several investigators solved the problem, and attempts to make the new explosive commercially were common. Unfortunately the earlier product was unstable, and several disastrous accidents occurred which led to the abandonment of the experiments, except in Austria. General von Lenk, who continued experimenting in that country, showed that if sufficient care was taken to ensure complete nitration and to remove all traces of free acid from the finished material, the substance was stable. He introduced a method of manufacture which was improved by Sir Frederick Abel in 1865. The physical character of the cotton fiber is such that it presents every obstacle to the removal of free acid, since it is built up of capillaries, but by reducing these tubes to the shortest possible length, as in Abel's process, the removal of acid is facilitated.

Since water is a product of the reaction of nitric acid on cellulose, the nitric acid would become diluted, forming "collodion cotton" instead of the more highly nitrated guncotton, and, therefore, sulphuric acid is used with the nitric acid to absorb this water, the usual proportions being 3 parts by weight of sulphuric acid (1·84) to 1 part by weight of nitric acid (1·52). Cotton waste, which has been picked, cleaned, cut into short lengths, and dried, is dipped in 1¼ pound charges in the acid, removed after five or six minutes, the excess of acid squeezed out, and the cotton placed in cooled earthenware pots for some twenty-four hours for nitration to be completed. The guncotton now goes through the lengthy process for removal of all traces of acid, starting with the removal of the greater portion of the acid by a centrifugal extractor, washing in water till no acid taste can be detected, boiling in water till free from action on litmus, reducing to pulp in a hollander, and, finally, the thorough washing of the pulp by more water. If the product now satisfies the tests of purity, sufficient alkali—limewater, whiting, and caustic soda—is added to leave from one to two per cent. in the finished guncotton. The pulp is drawn up into a vessel from which it can be run off in measured quantities into molds fitted with perforated bottoms, the water being drawn off by suction from below, and, finally, a low hydraulic pressure is brought to bear on the semi-solid mass. The blocks are taken to the press house and submitted to a pressure of some five tons per square inch, after which the finished block will contain from 12 to 16 per cent. of water.

From its chemical reactions guncotton must be regarded as an ether of nitric acid, a view first suggested by Béchamp. The point of ignition of the substance has been found to vary considerably, ranging from 136° to 223° C., this difference being probably due to variations in composition. Good guncotton usually ignites between 180° and 184° C. The combustion is extremely rapid when fired in loose unconfined masses, so rapid, in fact, that it may be ignited on a heap of gunpowder without affecting the latter. When struck between hard surfaces guncotton detonates, but usually only in that position which is subjected to the blow. The volume of permanent gases evolved by the explosion of guncotton, as stated by different observers, has varied greatly. Macnab and Ristori give for nitrocellulose—13·30 per cent. nitrogen=673 c.c. per gramme, calculated at 0° C. and 760 mm. Berthelot estimates the pressure developed by the detonation of guncotton—sp. gr. 1·1 under constant volume as 24,000 atmospheres, or 160 tons per square inch.

Various attempts have been made to adapt guncotton for use in guns, but the tendency to create undue pressure led to its abandonment. In 1868, Mr. E. O. Brown, of Woolwich, showed that wet guncotton could be detonated by the use of a small charge of dry guncotton with a fulminate detonator, and since it can be stored and used in the moist state, it becomes one of the safest explosives for use in submarine mines, torpedoes, etc.

Nitroglycerine is a substance of a similar chemical nature to nitrocellulose, the principles of its formation and purification being very similar, only in this case the materials and product are liquids, this rendering the operations of manufacture and washing much less difficult. The glycerine is sprayed into the acid mixture by compressed air injectors, care being taken that the temperature during nitration does not rise above 30° C. The nitroglycerine formed readily separates from the mixed acids, and being insoluble in cold water, the washing is comparatively simple.

This explosive was discovered by Sobrero in 1847. Nitroglycerine is an oily liquid readily soluble in most organic solvents, but becomes solid at three or four degrees above the freezing point of water, and in this condition is less sensitive. It detonates when heated to 257° C., or by a sudden blow, yielding carbon dioxide, oxygen, nitrogen, and water. Being a fluid under ordinary conditions, its uses as an explosive were limited, and Nobel conceived the idea of mixing it with other substances which would act as absorbents, first using charcoal and afterward an infusorial earth, "kieselguhr," and obtaining what he termed "dynamite."

In 1875, Mr. Alfred Nobel found that "collodion cotton"—soluble guncotton—could be converted by treatment with nitroglycerine into a jelly-like mass which was more trustworthy in action than the components alone, and from its nature the substance was christened "blasting gelatine." The discovery is of importance, for it was undoubtedly the stepping-stone from which the well-known explosives ballistite, filite, and cordite were reached. In 1888, Nobel took out a patent for a smokeless powder for use in guns, in which these ingredients were adopted with or without the use of retarding agents. The powders of this class are ballistite and filite, the former being in sheets, the latter in threads. Originally camphor was introduced, but its use has been abandoned, a small quantity of aniline taking its place.

Sir Frederick Abel and Prof. Dewar patented in 1889 the use of trinitrocellulose and nitroglycerine, for although, as is well known, this form of nitrocellulose is not soluble in nitroglycerine, yet by dissolving the bodies in a mutual solvent, perfect incorporation can be attained. Acetone is the solvent used in the preparation of "cordite," and for all ammunition except blank charges a certain proportion of vaseline is also added. The combustion of the powder without vaseline gives products so free from solid or liquid substances that excessive friction of the projectile in the gun causes rapid wearing of the rifling, and it is chiefly to overcome this that the vaseline is introduced, for on explosion a thin film of solid matter is deposited in the gun, and acts as a lubricant.

The proportion of the ingredients are:

Nitroglycerine	58 parts.
Guncotton	37 "
Vaseline	5 "

Guncotton to be used for cordite is prepared as previously described, but the alkali is omitted, and the mass is not submitted to great pressure, to avoid making it so dense that ready absorption of nitroglycerine would not take place. The nitroglycerine is poured over the dried guncotton and first well mixed by hand, afterward in a kneading machine with the requisite quantity of acetone for three and a half hours. A water jacket is provided, since on mixing the temperature rises. The vaseline is now added, and the kneading continued for a similar period. The cordite paste is first subjected to a preliminary pressing, and is finally forced through a hole of the proper size in a plate either by hand or by hydraulic pressure. The smaller sizes are wound on drums, while the larger cordite is cut off in suitable lengths, the drums and cut material being dried at 100° F., thus driving off the remainder of the acetone.

Cordite varies from yellow to dark brown in color according to its thickness. When ignited it burns with a strong flame, which may be extinguished by a vigorous puff of air. Macnab and Ristori give the yield of permanent gases from English cordite as 647 c.c., containing a much higher per cent. of carbon monoxide than the gases evolved from the old form of powder. Sir Andrew Noble failed in attempts to detonate the substance, and a rifle bullet fired into the mass only caused it to burn quietly.

Lyddite is probably the explosive which has received most notice during the past few months. In 1873, Sprengel, in a paper read before the Chemical Society, stated that "picric acid alone contains a sufficient amount of oxygen to render it, without the help of

* A lecture delivered at the London Institution on February 12, by Mr. J. S. S. Brame.

foreign oxidizers, a powerful explosive when fired with a detonator. Its explosion is almost unaccompanied by smoke."

Picric acid was first prepared by Hausmann in 1878, by treating indigo with nitric acid. It may be made by the direct nitration of phenol (carbolic acid), but a better result is obtained by first dissolving the phenol in sulphuric acid, forming phenol sulphonic acid, which is dissolved in water, and nitrating this compound with nitric acid (1·4). On cooling, the picric acid separates out, and is purified by recrystallization from hot water, the yellow crystalline product being dried at a temperature not exceeding 100° C.

Picric acid containing as much as 17 per cent. of water can be detonated by a charge of dry picric powder; a thin layer may also be exploded by a blow between metal surfaces, its sensitiveness to shock being greatly increased by warming, for at a temperature just below its melting point a pound weight falling from a height of 14 inches will explode it.

The sensitiveness of picric acid can be reduced by converting the powder into larger masses, this being accomplished either by granulating it with a solution of collodion cotton in ether-alcohol, as in the earlier forms of mélinite, or by fusion, which takes place some twenty degrees above the boiling point of water, and casting directly into the shell, as in lyddite and possibly the mélinite of the present day. In any condition perfect detonation would yield only colorless gaseous products rich in carbon monoxide, but the bursting of a lyddite shell is frequently accompanied by a yellow smoke, probably formed by undecomposed acid in the form of vapor. The shells appear to burst in two distinct ways, in one case giving a sharp, powerful explosion with enormous concussion and no yellow smoke, and the other a heavy report with the yellow smoke, the two results appearing to be due to perfect decomposition in the first instance, while in the second partial decomposition only probably occurs.

Various mixtures of picric acid or its salts, together with some oxidizing agent, have been used from time to time, Abel's powder consisting of ammonium picrate, potassium nitrate, and a small quantity of charcoal.

It is impossible to deal with the numerous other explosives which are largely in use in such a survey as this, and, therefore, attention has been confined to those which play the most active part in modern warfare.

MOTOR VEHICLES FOR HEAVY TRAFFIC.

THERE is every indication that there is a great future for self-propelled heavy vehicles, and the Judges Report of the Liverpool Self-Propelled Traffic Association, edited by E. Shrapnell Smith, which has just come to hand, confirms this view. Trials were held in 1898 and in 1899.

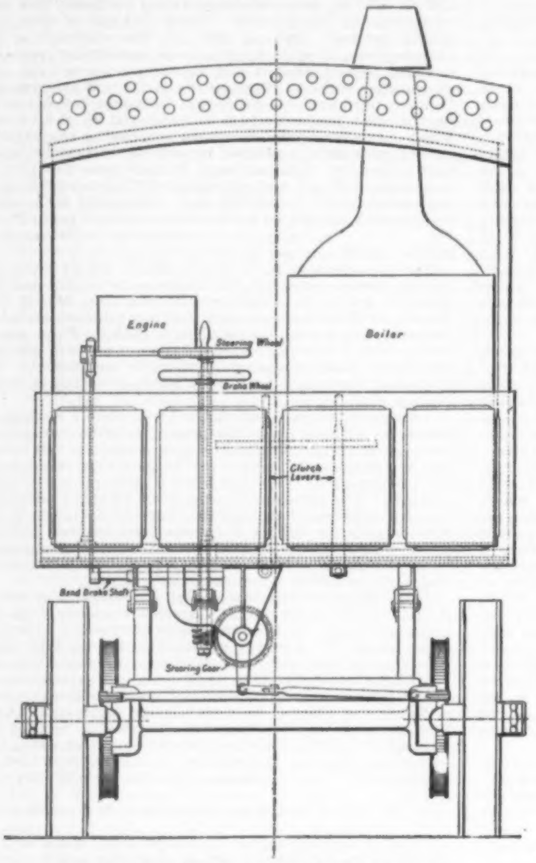
The chief object of the trials was "to encourage the development of types of heavy motor wagons suitable for trade and agricultural requirements in the neighborhood of Liverpool, which shall be capable of economically taking the place of horse haulage and of competing with the existing railway rates, in the transport of heavy loads of goods over distances of up to forty miles." Further objects were to afford motor vehicle builders an opportunity of demonstrating their ability to overcome the faults developed during the 1898 trials, to determine the progress being made in the country upon heavy automobilism, and to apply certain special tests recommended in the first report.

It was decided, in order to have exact comparisons, to relinquish the idea of running to Manchester, and to adhere to the routes covered in the 1898 trials. Each of these routes is between 35 and 36 miles in length and corresponds with the distance between Liverpool and many manufacturing towns in South and East Lancashire. The routes were announced prior to the competition, and it was open to any competitor to ride over them if he chose. They comprise some of the worst roads in Lancashire.

Elaborate rules and conditions were laid down, and the whole affair seems to have been managed in an admirable manner. No award was made in the Class A, which included very light vehicles, but in Class B, which included wagons capable of carrying a minimum load of 3½ tons, with a minimum platform area of 65 square feet, the gold medal was given to the Steam Carriage and Wagon Company, Limited, of Chiswick, and silver medals to Bayley's Limited, London and the Lancashire Steam Motor Company, Leyland. We illustrate some of the details of two types of lorry.

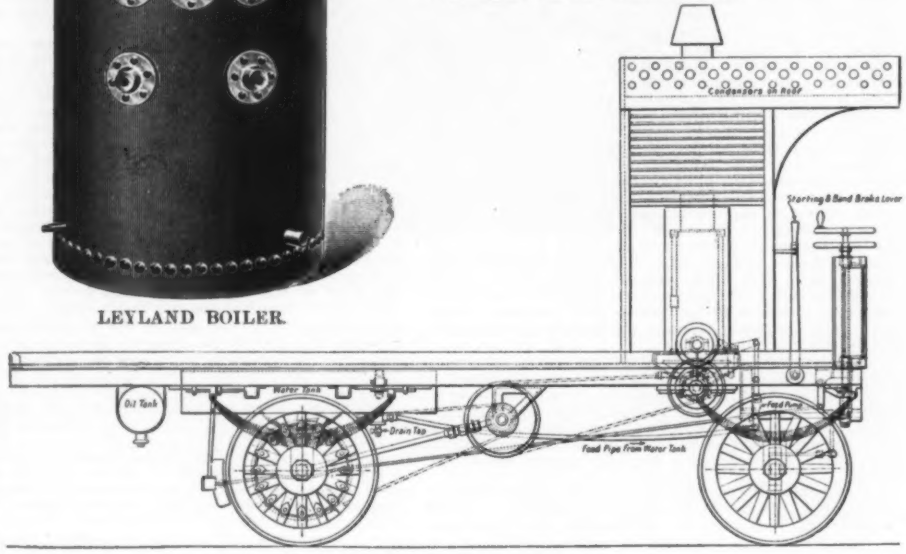
The Leyland lorry is 18 feet 2 inches long by 6 feet 5 inches extreme width over the hubs. The wheel base is 9 feet 11 inches longitudinally and 5 feet 3 inches transversely. The platform is carried on a steel frame and is 12 feet 6 inches long by 5 feet 8 inches wide and has 71 square feet of available surface for carrying goods. The height of the platform is 3 feet 9½ inches when light and 3 feet 7 inches when loaded with four tons. The wheels are 3 feet 3 inches in diameter. The front tires being 4 inches wide and the rear tires 5 inches wide.

A tubular boiler, shown in our engraving, is used. The water tank over the rear axle holds 50 gallons, and the oil tank at the extreme rear 20 gallons. The heating surface is 77 square feet, and the working pressure is 200 to 225 pounds, and the boiler is tested to 450 pounds to the square inch. The feed pump is driven from the engine shaft by gearing. Liquid fuel is used. The boiler and the vertical engine are enclosed in a kind of cab, in front of which stands the driver, who manipulates the wheels and levers for starting, stopping and reversing the engine, and for applying the brake. The horse power of the engine is 14 and sufficient fuel is carried to propel the lorry 37·1 miles, and the water tank must be refilled every 12½ miles. It weighs 3·258 tons and costs $2,250.



FRONT VIEW OF LEYLAND LORRY.

LEYLAND BOILER.

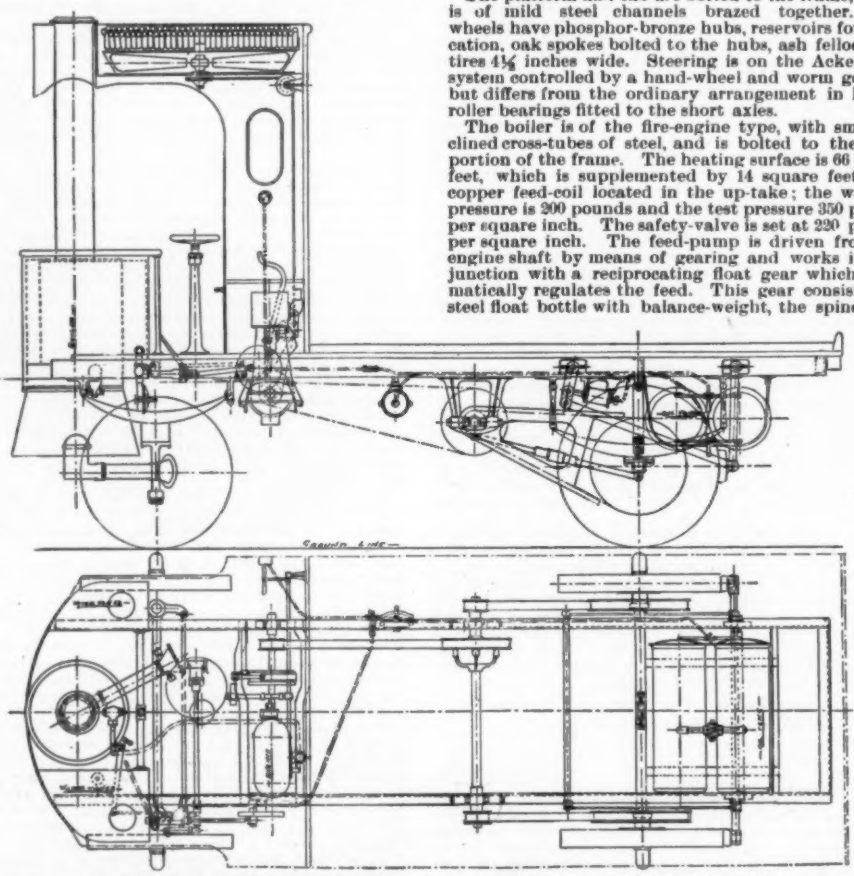


ELEVATION OF LEYLAND LORRY.

The Clarkson and Capel lorry, built in London, is 17 feet 9 inches long by 6 feet 5 inches extreme width over hubs. The wheel base is 9 feet 11 inches longitudinally and 5 feet 3 inches transversely. The platform is 11 feet long by 6 feet 4 inches wide and has 70 square feet of available space for carrying goods. The height of the platform is 4 feet when light and 3 feet 9½ inches when loaded with 3½ tons.

The platform and cab are bolted to the frame, which is of mild steel channels brazed together. The wheels have phosphor-bronze hubs, reservoirs for lubrication, oak spokes bolted to the hubs, ash felloes, and tires 4½ inches wide. Steering is on the Ackermann system controlled by a hand-wheel and worm gearing, but differs from the ordinary arrangement in having roller bearings fitted to the short axles.

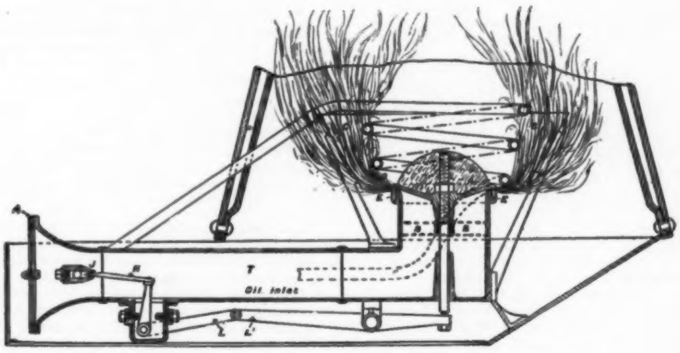
The boiler is of the fire-engine type, with small inclined cross-tubes of steel, and is bolted to the front portion of the frame. The heating surface is 66 square feet, which is supplemented by 14 square feet of a copper feed-coil located in the up-take; the working pressure is 200 pounds and the test pressure 350 pounds per square inch. The safety-valve is set at 220 pounds per square inch. The feed-pump is driven from the engine shaft by means of gearing and works in conjunction with a reciprocating float gear which automatically regulates the feed. This gear consists of a steel float bottle with balance-weight, the spindle be-



GENERAL ARRANGEMENT OF THE CLARKSON AND CAPEL LORRY.

ing kept free in the gland by a slight longitudinal movement communicated from the feed-pump by a suitable connection. Liquid fuel is employed to generate steam.

The company's patent burner, which is fitted to this vehicle, is of the true Bunsen type and consists essentially of a vaporizer, a regulated jet, and inducing tube, a mixing chamber, and a regulated orifice at which the vapor issues and is burnt. The vaporizer consists of a spiral coil of solid drawn steel tube made up in conical form, *V*, through which the oil passes on its way to the jet, *J*. To prevent over-heating, the coil is not in direct contact with the flame. The size



BURNER OF THE CLARKSON AND CAPEL LORRY.

of the jet is in direct proportion to the maximum power required, and the current can be regulated from full flame to just sufficient to keep the vaporizer hot, or any intermediate stage, by means of a needle, *N*, operating in the jet. The force of the vapor issuing from the jet induces with it a proportionate quantity of air, which passes along the inducing tube, *I*, to the mixing chamber, *BB*, where it is thoroughly mixed. The quantity of air induced being proportional to the amount of vapor issuing at the jet does not require any special regulating device, but a damper, *A*, is provided at the end of the inducing tube for special cases, e. g., for use with forced draught and in starting the burner. A perforated nickel cone, *C*, surrounds the orifice, *EE*, at which the flame issues, with a view to improving the combustion and as a radiator and igniter in case of the burner being blown out.

The mixture of air and vapor issues from the regulated circular orifice at the top of the mixing chamber or "cap" of the burner and burns with a blue flame. The needle, *N*, and the cap at which the vapor issues are connected by levers, *LL*, and operate in conjunction with one another; as the needle is withdrawn from the jet, allowing more vapor to issue, the outlet, *O*, at which the mixture issues is increased in the same proportion and vice versa. This regulation, by means of which it is impossible for the burner to "light back" and burn at the jet, was effected by hand, but a connection can be made to the main steam pipe for automatic control. The preliminary mixing of the air and vapor improves the combustion, prevents smoke and enables a more intense flame to be produced in a firebox of given dimensions than would otherwise be possible.

A special starter was fitted to the burner, consisting of a separate spiral coil of steel tube, placed in a small circular sheet-iron box, and connected on one side to the main oil supply and on the other side to the jet of the burner. Oil is allowed to drip onto a small trough let into the circular box containing the starting-coil, and is lighted by hand, a small fan being provided to blow the flame into the circular box and onto the starting-coil. When the coil is sufficiently hot, the oil is turned on and vaporized on its passage through the coil to the jet. The damper, *A*, at the end of inducing tube is closed until vapor is seen issuing at the cap, *O*, when a light is applied and the damper opened. The starter is kept going until the main vaporizer coil is hot, when, by means of a three-way cock, the oil is turned from the starter to the burner and follows the course indicated in the figure.

The engine is vertical compound, reversing with cylinders, 2¾ inch and 6 inch diameter and 4-inch stroke, enclosed in a dust-proof and oil-tight casing, and is stated to develop 14 B. H. P. at 600 revolutions per minute. Piston valves are used in both cylinders. An atmospheric condenser is fitted on the roof of the cab, a propelling fan being used to circulate the air for cooling purposes. There is no hot-well, the condensed steam being returned direct to the feed-tanks. There is no lubrication to the cylinders.

The engine-shaft carries a two-speed gear of novel construction, of which the higher is put into engagement by an expanding clutch. A Renold's chain is used to transmit the power to the second motion shaft, which carries the compensating gear, and from it to the road wheels. The gearing gives a ratio of 12:1 or 36:1 between the engine and road wheels.

Two brakes are provided, in addition to the reversing of the engine for which a special lever is provided, viz., a band brake on the engine-shaft and a steam brake on each of the driving tires. The band brake is locked onto the high-speed clutch and cannot be used when the low gear is in use. The steam brake comes into operation by moving the steam regulating lever to an extreme position.

A special type of strainer, which admits of ready examination, is fitted to all water and oil pipes. The water tanks hold 49 gallons, and the oil tank 30 gallons.

Physicians in South Africa, says a press report, now have another theory for explaining away the charges made by both Briton and Boer that the other is using explosive bullets. The extensive laceration often found in bullet wounds is now said to be due to the air which the bullet drives before it into the wound. "The existence of this phenomenon can be proved easily. If a round bullet be dropped into a glass of water from the height of a few feet it will be seen that when the bullet touches the bottom a large bubble of air will become detached and rise to the surface. In this case the the bubble will usually be from ten to twenty times the size of the bullet. Now, a Mauser bullet traveling at high speed is said to carry before it a bubble of compressed air of large dimensions. Experiments made by a surgeon who fired a pistol ball into a glass of water showed the bubble to be one hundred times the size of the ball. From the appearance of the wounds, and from these experiments, it is concluded that the mass of air driven by a Mauser bullet explodes in the body of the wounded man with a sufficient force to cause extensive laceration. This destructive air bubble is well known to surgeons under the name of projectile air."

APPARATUS FOR FILTERING AIR AND SMOKE.

WILL absolute smoke consumption by industrial furnaces be at length accomplished? Before answering this question, let us in the first place see what is commonly understood by smoke consumption. Before discussing ideas, there is nothing like getting a perfect understanding of the words employed. This does away with ambiguity, which is always disagreeable, and with discussions which lead to nothing precise. Smoke is that blackish, thick and suffocating cloud which is disengaged from a furnace in combustion.

Can such smoke be totally suppressed? If it could be, we should have the ideal smoke consumption, but we must not forget that smoke is composed of several elements. In the first place, we find in it some solid particles that have been carried along by the current of air of the chimney. The proportion of such dust in smoke is variable, and depends upon the degree of activity of the furnace as well as upon the draught. It reaches its maximum at the time at which

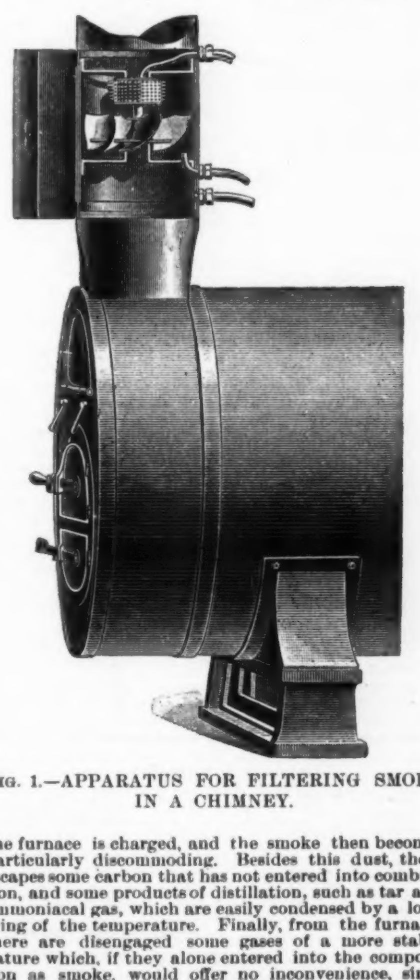


FIG. 1.—APPARATUS FOR FILTERING SMOKE IN A CHIMNEY.

the furnace is charged, and the smoke then becomes particularly discommoding. Besides this dust, there escapes some carbon that has not entered into combustion, and some products of distillation, such as tar and ammoniacal gas, which are easily condensed by a lowering of the temperature. Finally, from the furnace, there are disengaged some gases of a more stable nature which, if they alone entered into the composition as smoke, would offer no inconvenience, since they have no appreciable color and become diffused through the atmosphere as soon as they leave the chimney. We can say, then, that real smoke consumption would be accomplished if these gases alone escaped from a chimney. The object to be attained, then, is to arrest on their passage all the solid particles held in suspension in the smoke, to condense the tar before it leaves the chimney, and, at the same time to dissolve the ammoniacal vapor. An apparatus responding to such desiderata has been devised by M. Alexandre Lion. We have had an opportunity of seeing this operate under rather adverse conditions, and have been able to judge of its certain efficiency from the point of view at which we were placed. The inventor calls his apparatus a smoke or air filter, since the principle is applicable to any gaseous mass whatever, it simply sufficing to cause the latter to pass through a spray of water.

Several types of the apparatus are constructed, but we shall describe only the one represented in the accompanying figures, and which is specially designed for use upon locomotives

A shaft provided with screw blades and carrying a cylinder, *P*, is mounted in an external cylinder placed

FIG. 2.—APPARATUS FOR FILTERING SMOKE.

in the smokestack. One or more jets of water or steam, entering through nozzles, being directed against the blades of the screw, set the latter and the cylinder, *P*, in motion. In order to accelerate this rotary motion, exhaust steam is sent through the lower part of the apparatus. The screw, in revolving, converts the jets of water that strike it into a fine spray, and the smoke from the furnace, upon traversing the latter, is completely freed from all the dust and black solid particles that it contains. Moreover, the gases soluble in water are arrested, while the vapors of tar are at the same time condensed. The water thrown against the sides of the apparatus collects and flows into a gutter, *G*, and makes its exit at *C*.

It is only the more stable gases that traverse the spray; and at the top of the smokestack all that is observed is a tenuous whitish cloud which almost immediately disappears within a radius of a few yards. In the water collected upon its exit from the apparatus we find all the materials that serve to render smoke black. Aside from this advantage, M. Lion's filter offers another, which is too important to be overlooked, and that is that the apparatus increases the draught instead of diminishing it.

M. Lion's apparatus for filtering the air that enters apartments (Fig. 3), is in all respects analogous to the preceding. With an inlet of from 3 to 4-inch section, it allows about 350 cubic feet of air to enter a room per

FIG. 3.—APPARATUS FOR FILTERING AIR.

minute, say 21,000 cubic feet per hour. Bacteriological analyses made of such air have shown it to be perfectly sterile.—Revue Industrielle.

"**Certainly** one good result," says The Western Electrician, "grows out of the occupation of the Philippine Islands by the Americans—the extension of electrical means of communication. When Spain turned the islands over to the United States there were about 1,800 miles of telegraph lines in the archipelago, and it is estimated that within a year the total length of wire in operation will be fully 5,000 miles. New lines are building in Luzon and on the islands in the south-

ern part of the archipelago. The latest reports from Manila show that there are being handled by the Signal Corps in Luzon alone an average of 4,600 messages daily, and as new territory is occupied the work correspondingly increases."

ACTINIUM: A NEW RADIO-ACTIVE ELEMENT.

By A. DEBIERNE.

I SHOWED in a previous paper that there exists in residues from pitchblende, apart from the radium and polonium discovered by M. and Mdme. Curie, a new radio-active substance belonging to the iron group. I further showed that this substance was precipitated by the principal re-agents for titanium.

I have continued my researches with the object of obtaining this body, and I have proved that titanium does not resemble it in all its reactions. In addition to the reactions common to all the elements of the iron group (precipitation by ammonia, ammonium sulphide, soda, sodium carbonate, etc.), the following methods appear to be the best to concentrate the new substance:

1. Precipitation of the Boiling Solution, slightly Acidulated with HCl, by excess of Sodium Hyposulphite.—The radio-active property is found to reside almost entirely in the precipitate.

2. Action of Hydrofluoric Acid and Potassium Fluoride on the Freshly-precipitated Hydrates suspended in Water.—The soluble portion is only slightly active. This method is useful for the separation of titanium from the new substance.

3. Precipitation of the Neutral Nitrate Solutions by H_2O_2.—The precipitate contains the radio-active body.

4. Precipitation of the Insoluble Sulphates.—Each time that an insoluble sulphate (e. g., barium sulphate) is precipitated in a solution containing this body, the latter is retained, the precipitate being strongly radio-active. This process, which I have found most useful, is entirely different from methods usually employed for the separation of elements.

Oxalic acid, which precipitates the radio-active material well when it is mixed with a tolerably large proportion of the rare earths, seems to be much less efficacious when a number of elements unprecipitated by oxalic acid are present.

These different reactions cannot yet be considered as belonging definitely to the new radio-active substance, because up to the present it has not been obtained sufficiently concentrated. I believe rather that these reactions should be looked upon as the result of retention, analogous to that of iron oxide by barium sulphate.

By using, in a methodical manner, the different methods described above, I was able to extract from the residues of pitchblende the greater part of this new substance which the mineral contained.

The chemical reactions of the most active substance which I obtained, together with the spectroscopic examination, kindly undertaken by M. Demarçay, show that it chiefly consists of thorium. I cannot, however, be sure that it resembles thorium in all its reactions.

If we add a salt of barium or of bismuth to a solution of this substance we can very easily, by the action of ammonia, or H_2S, eliminate the substance having the radio-active property, thereby proving it to be neither radium nor polonium.

I therefore suppose that it is due to the presence of a new radio-active element which I shall call actinium.

It is possible to produce, with the rays emitted by actinium, the same phenomena (fluorescence of barium platinocyanide, photographic impressions, ionization of gases) as those of the rays emitted by radium and polonium.

Similarly I was able to repeat with this body the experiments of MM. Giesel, Meyer, and V. Schweidler and Becquerel on the action of a magnetic field. Under the influence of an intense magnetic field the rays of actinium, or rather a portion of the rays, are deviated, and will impress a photographic plate situated below a lead cell containing the substance.

The deviation is in the same direction as that of the rays of radium or of cathode rays, i. e., it corresponds to a negative charge of the rays.

Finally, actinium, only very feebly, provokes the induced permanent radio-activity discovered by M. and Mdme. Curie on bodies placed in contact or near other radio-active substances. We know that thorium compounds are slightly radio-active. We know further, from what has been said, that actinium seems to be an element allied to thorium. We can, therefore, suppose that the radio-active property observed in thorium compounds does not belong to this element, but is due to a foreign material. Recent experiments on the radio-activity of thorium made by Rutherford lead also to the same supposition. I propose, therefore, to try whether it be possible, by utilizing the reactions described above, to deprive the thorium compounds of their radio-active property, or to extract from its compounds a substance identical with the actinium extracted from pitchblende.—Comptes Rendus, cxxx, No. 14, April 2, 1900.

Commercial Conditions in Mexico.—Consul Griffith, of Matamoros, on February 21, 1900, writes:

Confidence in the stability of the present business prosperity has been conclusively shown during the past winter by the increasing interest evidenced by prominent northern capitalists. Many have visited the republic, not only in order to investigate purchases previously acquired, but also to make additional investments in favorable agricultural and mining properties. Such handsome dividends have been realized from many of these investments that the owners are very enthusiastic. It is a well-known fact that the commercial interests of this country are unaffected by labor disturbances or panics. Mexico's proposition to decrease the present rate of taxation, which will enable her to redeem outstanding bonds bearing a high rate of interest and to undertake many needed public improvements, is the culminating proof of the excellent condition of her treasury. While in some branches of industry and trade, during the past year, the gains have been moderate, in many the expansion of business has been marvelous. Prospective United States investors may be interested to know of the confidence shown by some of their most prominent countrymen in the business solidity of this country, and at the same time to be assured of the settled determination on the part of the administration to continue its present policy.

TRADE NOTES AND RECEIPTS.

Toilet Waters.—Original receipts by E. Gips.

EAU DE COLOGNE.

1.	Alcohol 90 per cent	5 kilos.
	Bergamot oil	220 grammes.
	Lemon oil	75 "
	Neroli oil	20 "
	Rosemary oil	5 "
	Lavender oil, French	5 "

The oils are well dissolved in spirit and left alone for a few days with frequent shaking. Next add about 40 grammes of acetic acid and filter after awhile.

2.	Alcohol 90 per cent	5 kilos.
	Lavender oil, French	35 grammes.
	Lemon oil	30 "
	Portugallo oil	30 "
	Neroli oil	15 "
	Bergamot oil	15 "
	Petit grain oil	4 "
	Rosemary oil	4 "
	Orange water	700 "
3.	Alcohol 90 per cent	5 kilos.
	Neroli oil	70 grammes.
	Rosemary oil	35 "
	Bergamot oil	35 "
	Orange oil	20 "
	Lemon oil	20 "
4.	Alcohol 90 per cent	5 kilos.
	Bergamot oil	125 grammes.
	Portugallo oil	30 "
	Lemon oil	30 "
	Sweet orange oil	30 "
	Lavender oil, A1	15 "
	Neroli oil	25 "
	Rosemary oil	20 "
	Thyme oil	1 "
	Orange water	250 "
5.	Alcohol 90 per cent	5 kilos.
	Lemon oil	40 grammes.
	Bitter orange oil	40 "
	Orange oil	20 "
	Bergamot oil	15 "
	Petit grain oil	7 "
	Rosemary oil	7 "
6.	Alcohol 90 per cent	5 kilos.
	Bergamot oil	100 grammes.
	Balm oil	15 "
	Lemon oil	15 "
	Orange oil	8 "
	Lavender oil	8 "

EAU DE LAVANDE.

Dissolve 3 kilos of spirit 90 per cent. in 130 grammes of lavender oil and add 200 grammes of rose water.

EAU DE LAVANDE, DOUBLE AMBRÉE.

Alcohol 90 per cent	5 kilos.
Lavender oil	85 grammes.
Lemon oil	10 "
Geranium oil, African	5 "
Peru balsam	32 "
Musk tincture	50 "
Civet tincture	25 "
Liquid storax	50 "

EAU DE PORTUGAL.

Alcohol 90 per cent	5 kilos.
Portugallo oil	400 grammes.
Lemon oil	120 "
Bergamot oil	60 "
Geranium oil, African	20 "

EAU DE MILLE FLEURS.

Dissolve:

Peru balsam	60 grammes.
Bergamot oil	120 "
Clove oil	60 "
Neroli oil	15 "
Thyme oil	15 "
in Alcohol	3 kilos.

Then add:

Orange-flower water	2 kilos.
Musk tincture	60 grammes.
and Civet tincture	60 "

EAU D'ESPANGE.

Alcohol 90 per cent	5 kilos.
Bergamot oil	80 grammes.
Neroli oil	25 "
Lemon oil	30 "
Rosemary oil	6 "
Orange-flower water	150 "

EAU DE COLOGNE DOUBLE.

Spirit of wine A1, 96 per cent	5 kilos.
Petit grain oil	40 grammes.
Orange oil	35 "
Bergamot oil	30 "
Portugallo oil	30 "
Rosemary oil	30 "
Lavender oil	30 "
Sweet orange oil	30 "
Jessamine water	60 "
Rose water	60 "
Orange flower water	60 "

The volatile oils should be well dissolved in spirit of wine.

EAU DE RONDELITIA.

Alcohol 90 per cent	3½ kilos.
Lavender oil	60 grammes.
Bergamot oil	36 "
Clove oil	30 "
Rose oil	10 "
Vanilla tincture	120 "
Ambergris tincture	120 "
Musk tincture	120 "

—Seifensieder Zeitung.

To Remove the Iodoform Odor.—Ricketts recommends, as a simple and certain remedy, rubbing with about a teaspoonful of wine vinegar, after a previous thorough washing with soap.—Münchener Medicinische Wochenschrift.

SELECTED FORMULÆ.

Black Starch.—Add to the starch a certain amount of logwood extract before the starch mixture is boiled. The quantity varies according to the depth of the black and the amount of starch. A small quantity of potassium bichromate dissolved in hot water is used to bring out the proper shade of black. In place of bichromate, black iron liquor may be used. It comes ready prepared. Preparations of this kind are used in various industries.

To Remove Stains from Marble.—

1.	Sodium carbonate	2 parts.
	Levigated pumice	1 "
	Finely powdered chalk	1 "

Mix and pass through a fine sieve; make a thin paste of this with water and rub it well over the marble or tile, allow to stand for some time and then wash with soap and water.

2.	Soft soap	4 ounces.
	Whiting	4 "
	Sodium carbonate	1 "
	Water, a sufficient quantity.	

Make into a thin paste, apply on the soiled surface and wash off after twenty-four hours.—Druggists' Circular.

To Japan Tin.—The first thing to be done when a vessel is to be japanned, is to free it from all grease and oil, by rubbing it with turpentine. Should the oil, however, be linseed, it may be allowed to remain on the vessel, which must in that case be put in an oven and heated till the oil becomes quite hard.

After these preliminaries, a paint of the shade desired, ground in linseed oil, is applied. For brown, umber may be used.

When the paint has been satisfactorily applied it should be hardened by heating, and then smoothed down by rubbing with ground pumice stone applied gently by means of a piece of felt moistened with water. To be done well, this requires care and patience, and, it might be added, some experience.

The vessel is next coated with a varnish, made by the following formula:

Turpentine spirit	8 ounces.
Oil of lavender	6 "
Camphor	1 drachm.
Bruised copal	2 ounces.

Perhaps some other good varnish would give equally satisfactory results.

After this the vessel is put in an oven and heated to as high a temperature as it will bear without causing the varnish to blister or run. When the varnish has become hard, the vessel is taken out and another coat is put on, which is submitted to heat as before. This process may be repeated till the judgment of the operator tells him that it is no longer advisable.

Some operators mix the coloring matter directly with the varnish; when this is done care should be taken that the pigment is first reduced to an impalpable powder, and then thoroughly mixed with the liquid.—Druggists' Circular.

Simple Tinctures for Perfume Compositions.—

a. Ambergris, 1 part; alcohol, 96 per cent., 15 parts.

b. Benzoin, Sumatra, 1 part; alcohol, 96 per cent., 6 parts.

c. Musk, 1 part; distilled water, 25 parts; spirit, 96 per cent., 25 parts.

d. Musk, 1 part; spirit, 96 per cent., 50 parts; for very oleiferous compositions.

e. Peru balsam, 1 part in spirit, 96 per cent., 7 parts; shake vigorously.

f. Storax, 1 part in spirit, 96 per cent., 15 parts.

g. Powdered Tolu balsam, 1 part; spirit, 96 per cent., 6 parts.

h. Chopped Tonka beans, 1 part; spirit, 60 per cent., 6 parts; for compositions containing little oil.

i. Chopped Tonka beans, 1 part; spirit, 96 per cent., 6 parts; for compositions containing much oil.

k. Vanilla, 1 part; spirit, 60 per cent., 6 parts; for compositions containing little oil.

l. Vanilla, 1 part; spirit, 96 per cent., 6 parts; for compositions containing much oil.

m. Vanillin, 20 parts; spirit, 96 per cent., 4,500 grammes.

n. Powdered orris root, 1 part; spirit, 96 per cent., 5 parts.

o. Grated civet, 1 part in spirit, 96 per cent., 10 parts.—E. Gips, in Seifensieder Zeitung.

Mending Porcelain by Riveting.—While the pharmacist can scarcely be expected to do more in the way of repairing broken porcelain than to furnish a suitable cement, it may be of interest to him to know for the benefit of his customers as well as himself, how the work may be done by riveting. According to the Metallarbeiter, porcelain (and glass) can be quite readily pierced with steel tools. Best suited are hardened drills of ordinary shape, moistened with oil of turpentine, if the glaze or vitreous body is to be pierced. In the case of majolica and glass without enamel the purpose is best reached if the drilling is done under water. Thus, the vessel should previously be filled with water and placed in a receptacle containing water, so that the drill is used under water, and, after piercing the clay body, reaches the water again. In the case of objects glazed on the inside, instead of filling them with water, the spot where the drill must come through may be underlaid with cork. The pressure with which the drill is worked is determined by the hardness of the material, but when the tool is about to reach the other side it should gradually decrease and finally cease almost altogether, so as to avoid chipping. In order to enlarge small-bore holes already existing, three-cornered or four-square broaches, ground and polished, are best adapted. These are likewise employed under water or, if the material is too hard (glass or enamel), moistened with oil of turpentine. The simultaneous use of oil of turpentine and water is most advisable in all cases, even where the nature of the article to be pierced does not admit the use of oil alone, as in the case of majolica and non-glazed porcelain, which absorb the oil, without the use of water.—Druggists' Circular.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Clothing for the Transvaal.—Vice-Consul-General Hanauer, of Frankfort, March 2, 1900, writes: Late German papers report an order of 56,000 overcoats, jackets, and trousers for men's wear given by agents from the Transvaal to Hamburg and Berlin clothing manufacturers. At the same time, heavy orders for cassimeres were received for the Boers' use. The United States should not overlook the opportunities in the line of ready-made clothing, not only in Africa, but in Central and South America, Australia, etc.

Traction Railway in Nicaragua.—Consul Donaldson, of Managua, under date of March 6, 1900, sends a letter from Consular Agent Manning, of Matagalpa, as follows:

A company has been organized, incorporated under a very favorable charter by the Government of Nicaragua, with the title, "Compañía de Trasportes de Matagalpa, Limitado" (capital stock, $20,000), for the purpose of doing a general freight and passenger transportation business between this point and the national railway at Momotombo, or Leon. The stock is all subscribed, and the company perfected organization yesterday by electing Mr. William H. De Savigny president and Mr. Nicholas A. De Daney secretary. It is intended to place improved traction wagons, or "traction trains," on the road as soon as there can be found a company willing to demonstrate the ability of its wagons, or trains, to travel over the roads and do the work required. It seems to me that this is a good field for the traction companies of the United States to look into. The export from here next year will amount to at least 18,000 to 20,000 bags of coffee, and half as much freight will be required to supply the district, which will be brought up from the railroads. The distance is nearly 110 miles, and I can see no serious obstacles to the use of these freighting machines. Undoubtedly, an effort will be made to induce the company to buy English or, perhaps, German machines; but I think neither will bear comparison with American ones.

Projected Railroad in Nicaragua.—Consul Donaldson sends the following from Managua, March 15, 1900:

The Nicaraguan government is anxious to extend the railroad system to the Atlantic by way of Rama and Bluefields. Bids have not yet been advertised for, but an effort is being made to arrange for the immediate construction of a line either to connect Rama with the railroad now in operation between Managua and Granada or with Lake Nicaragua at San Ubaldo. The distance is about 150 miles in the former, and about 105 miles in the latter. The government will give as guaranty for this work a certain percentage of the import duty collected at Bluefields. The estimated cost is about $2,000,000.

Mining in British Columbia: Canada's Mineral Output.—The Discoverers' Financial Corporation and the Universal Corporation, of London, England, will, during the present year, dredge the Saskatchewan River, British Columbia, for gold, says Gustave Beutelspacher, Commercial Agent, at Moncton. It is stated that an English mining engineer (Mr. F. B. Hobsen) has arrived in Montreal from London en route for Edmonton. When he first made representations to London as regards the feasibility of placer mining on the Saskatchewan, he was asked what the bad points were, and replied that in the opinion of some people the fineness of the gold found in the sands might preclude the saving of paying quantities, but they had discovered a process by which at least 75 per cent. can be saved.

The gold holding gravel in the river bed averages a depth of 7 feet, although it has been known to go as deep as 25 feet.

The plant used is called a New Zealand dredge, the cost of which is in the neighborhood of $25,000. It requires three hands and a master to man each one. These dredges work something like those seen every summer in the St. Lawrence channel between Quebec and Montreal. Water is being used to separate the gold from the earth. It is stated that from tests made in hundreds of places in the river the gravel will produce an average of 25 cents per cubic yard, and that this earth, consisting of 2 tons, can be handled for 2 cents per cubic yard. The handling of 3,000 yards is estimated to be a day's work.

According to a report issued by the geological survey, the mineral output of Canada for the year 1899 is placed at $47,000,000. Of this sum, gold is the largest factor, the total being $21,049,000, and of which the Yukon contributed $16,000,000. Coal is the next item of importance, the production for the year 1899 being $9,040,000. Since 1896, the mineral production of Canada has well-nigh doubled in value. The production of other minerals was: Iron, $248,372; lead, $977,250; nickel, $2,067,840; platinum, $835; silver, $1,834,371.

Of the chief contributors to the total mineral production of the country, lead and silver are the only two showing a considerable falling off, and that notwithstanding more favorable prices. This is due to local causes in British Columbia not dependent on the value of the deposits.

American Pork in Turkey.—According to a report from Consul-General Dickinson, of Constantinople, dated March 27, 1900, the admission of pork products from the United States into Turkey is prohibited by an order of the Porte. This order, it seems, was made about seventeen years ago, and, in spite of strenuous efforts on the part of the consul-general and of Minister Straus for several months past, the order has not yet been repealed. Mr. Dickinson adds:

In the last six months, I have secured the admission of several consignments of American hams, bacon, and other pork products at this port; but during this period American hams have been refused admission at Smyrna and Beirut, and one consignment spoiled at Smyrna while the question was being discussed at the Porte.

In view of the facts, I consider it unsafe to ship American pork products directly to Turkey until the order referred to is repealed. It is understood that a very large part of the hams, bacon, etc., received in this country is American, but that they are first shipped to Hamburg, Liverpool, and other European cities and then resold to dealers in this country.

On April 5, Mr. Dickinson writes that the Porte has given notice in effect that the order prohibiting the importation of American pork will not be repealed, but will hereafter be strictly enforced.

Electric Tramways in Germany.—Consul Hughes, of Coburg, on March 7, 1900, quotes from a trade journal the statement that the length of electric lines in Germany shows an increase of 45 per cent. over last year, the available power has gone up 57 per cent., and the growth of accumulator installations is represented by the figure of 164 per cent. The tramway accumulators now aggregate almost exactly a fourth of the dynamo power of the power stations; yet there are very few pure accumulator lines. Overhead conductors continue to predominate. Apart from the two pioneer lines of Siemens and Halske, at Berlin and Frankfort, of the years 1881 and 1884, all the electric roads have been built within the last nine years. The total length is 1,274 miles. Most lines have only a single track, which is made feasible by the almost universal practice of stopping at certain points only. The gas tram line at Dessau, which was considered so successful, will adopt electricity the coming summer.

New French-English Cable.—Consul Thackara, of Havre, on March 22, 1900, reports that a new submarine telegraphic cable has been laid between Havre (St. Denis Chef de Caux) and Cuckmen, near Beachy Head, England, by the steamship "Britannia," for the Anglo-American Telegraph Company. The length of the cable is 81·3 knots. The land connections in England and France will be completed in five or six weeks. As soon as the new cable has been connected with its London wire, the Brest cable will no longer be used by the Anglo-American Telegraph Company.

San Jose Scale Act in Canada.—Consul-General Turner, of Ottawa, on March 28, 1900, writes:

Hon. Sidney Fisher, Minister of Agriculture, gave notice yesterday in the House of Commons that the Department of Agriculture was to amend the act relating to the San Jose scale and allow the importation of shrubs, etc., now prohibited, under certain conditions of fumigation, and that fumigating stations would be established in several points of Canada.

Public Works at Vladivostock.—The Department has received a report from Consul Greener, of Vladivostock, to the effect that the municipality of that city has made estimates for 20 miles of electric-trolley road; also for electric lights and waterworks. Proposals should be made by United States contractors.

Liege School of Firearms.—In this city there is established an industrial school, known as the Ecole Professionnelle d'Armurerie, founded in 1896 by the city of Liege, the government, and the province, where thorough instruction is given in the manufacture of firearms, say Consul Alfred A. Winslow, of Liege.

The complete course covers a period of three years, and is divided into theoretical and practical. The theoretical covers drawing, lectures on the strength and combination of steel and iron, etc. The practical consists of several departments, such as wood working, engraving, and polishing, each presided over by a competent instructor.

Tuition is free, and besides the pupil is paid 25 centimes (5 cents) per day, and on completing his course receives a sum equal to 25 per cent. of the sales of his finished work.

This school opened with 8 pupils, and at present has 115 in the different departments, which is its limit. Arrangements are about completed for materially enlarging the buildings during the coming summer to provide accommodations for more than 200.

Pupils from the school have no difficulty, I am informed, in securing positions at good wages for this country, which is from 4 to 6 francs (77 cents to $1.15) per day, while ordinary workmen receive from 2·50 to 4 francs (49 to 77 cents) per day.

The important position occupied by the school will be realized when it is understood that about 30,000 persons in this city and immediate vicinity are employed in the firearms industry. The object of the institution is to qualify workmen for responsible positions in the different factories, since for the past few years nearly all are employed on piece work, which does not fit men for positions requiring a general knowledge of the business. This put the manufacturers at a great disadvantage, as it was becoming nearly impossible to secure competent foremen and superintendents of departments.

For several centuries, the manufacture of firearms has been the leading industry of Liege and vicinity, and the city maintains an extensive museum of firearms.

It is interesting to note that several thousand of the old flint-lock guns are still manufactured here each year for the trade in the interior of Africa, the natives preferring them to the modern guns.

Steel Rail Contract in New South Wales.—Consul Goding sends from Newcastle, February 26, 1900, clipping from the Sidney Telegraph of February 19, showing why American bidders failed to obtain a recent contract for rails in the colony. Had the firms mentioned, says Mr. Goding, offered the same terms that were given by the English, this immense order would have been supplied by our manufacturers. The article reads:

In response to the invitation of the works department, tenders have been received from English and American firms for 19,000 tons of steel rails, fish plates, bolts and nuts. Two offers were obtained from the United States and several from Great Britain. After allowing for shipping charges, etc., the lowest tenderer was an Illinois company at £151,417 10s. ($736,873); the next was the Barrow Company, of Great Britain, at £152,727 10s. ($743,245), also allowing for shipping charges. In connection with the Illinois company, however, there were certain stipulations about exchange which would mean extra expense, and a condition that the government of New South Wales should have a banker's credit, which would mean paying a commission to some American firm. These conditions would bring the tender of the Illinois company to somewhere about that of the lowest English tenderer. The members of the tender board agreed with the minister in giving the contract to the Barrow Company, of Great Britain, and the under secretary in his minute on the matter states: "I am quite sure that when the exchange and expenses were paid in connection with the Illinois company's tender, it would cost more than the Barrow Company's offer."

Shoe Prices in Prussia.—Consul Warner writes from Leipzig, March 7, 1900:

The boot and shoe manufacturers of Weissenfels, Prussia, according to The Leipziger Tageblatt, have increased the price of boots and shoes 5 per cent. It is said that this action on the part of the manufacturers is due to the fact that the price of leather has been recently advanced.

Quarantine in the Canaries.—Consul Berliner writes from Teneriffe, February 12, 1900, that on the 10th a very rigid quarantine was declared against vessels coming from Argentina. The quarantine regulations against Madeira have been taken off.

German Demand for Coal.—Vice-Consul-General Hanauer, of Frankfort, on April 10, 1900, reports that a reputable coal dealer of that city (who supplies one of the largest chemical factories in the vicinity) has just called on him in order to learn the names of standard coal companies in the United States. He says his firm wants—if prices and quality and coal are suitable—a contract for 500,000 tons for the next twelve months. He also states that the production of Germany in this line is short of the demand this year by 4,000,000 tons.

Food for Soldiers in Germany.—Consul-General Guenther writes from Frankfort, March 12, 1900:

On March 9, the first batallion of the 174th Regiment commenced an eight days' march for the purpose of determining the nutritive value of egg crackers and of preserved meat and vegetables, recently manufactured by a firm in Mainz. The crackers are distributed in place of bread; the preserves contain meat and vegetables boiled together, and can be made ready for consumption in from 10 to 15 minutes. The marching exercises cover at first 30 kilometers ($18\frac{3}{4}$ miles) per day and are gradually increased. Officers as well as men are not allowed to partake of anything except the rations furnished. The barracks in which they will pass the night are closely watched so as to prevent the smuggling in of other food.

Trade Openings in Madagascar.—Consul Gibbs sends the following from Tamatave, March 6, 1900:

I am in receipt of an inquiry from M. Joseph de Floris, Mahanoro, Madagascar, for the names of American builders of steam launches, and from Messrs. Chan, Ming & Co., Tamatave, Madagascar, for the name of a commission agent with whom they may be able to do business direct with America. M. de Floris is a planter of means, and Messrs. Chan, Ming & Co. are the largest Chinese merchants here. It would be well to conduct the correspondence with the latter firm in French or Chinese.

Regulations for Travelers in Madagascar.—Consul Gibbs transmits from Tamatave, February 18, 1900, translation of a decree providing that every Frenchman or foreigner debarking in a port of the colony shall make, within forty-eight hours of his debarkation, a declaration of arrival at the police headquarters, or, if there is none, at those of the local administration, giving all information necessary to the establishment of his identity, family and Christian names, date and place of birth, profession, etc.

Cure for the Hoof and Mouth Disease.—Under date of March 6, 1900, Consul Schumann, of Mainz, transmits the following:

Prof. Dr. Winkler, of Giessen, Hesse, claims to have discovered an extremely simple means for preventing the spread of the hoof and mouth disease (Eczema epizootica), a disease which is unusually prevalent among the cattle of this country and which it seems impossible to stamp out. Professor Winkler claims that well-boiled milk of cattle afflicted with the disease given to healthy cattle causes the latter immunity to the disease.

To make cattle immune it is necessary to feed 4 to 6 quarts of the said milk daily to each animal for a period of about eight days. Even though this remedy has not been given such thorough trials as to prove its infallibility beyond doubt, it is nevertheless so simple and inexpensive as to recommend itself at least for trial.

Cast Horseshoes in Germany.—Consul Kehl writes from Stettin, February 9, 1900:

Cast horseshoes are manufactured to a considerable extent at Ueckermünde, close to Stettin. The shoes are cast without toe or heels, although heels can be attached, holes being left at the end of the curves for that purpose. A square groove, commencing about 1 inch from the end of each curve, is formed in the bottom part of each shoe. This groove is filled very tightly with one piece of $\frac{3}{4}$-inch tarred hemp rope. The wholesale price for any size or shape is 36 marks ($8.56) per 100 kilogrammes (220·46 pounds). A set of shoes (medium size) weighs $5\frac{1}{2}$ pounds and would cost about 21 cents wholesale.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

A UNIVERSAL BORING AND TAPPING MACHINE.

IN manufacturing and repairing boilers, the work of drilling holes and of boring out old stay-bolts, as well as the cutting of screws, is largely performed by hand, for the reason that the many machines and tools which are intended for such work but inadequately meet the requirements of the mechanic. Most of these machines are applicable only to certain kinds of work. The functions which have hitherto been performed by specific machines have been very ingeniously combined by a German inventor, Paul Langbein, in a universal boring and tapping apparatus.

According to Glaser's "Annalen," the machine is noteworthy for its rapid and accurate adjustability. It is said that a new fire-box can be built in a locomotive boiler without previously marking or starting the bolts; for the machine drills these holes from the exterior so accurately that no reaming is necessary, and the thread can be immediately cut. There is a saving in time and likewise an improvement in the quality of the work.

The machine not only drills holes and cuts internal threads, but also beads over the ends of boiler flues on the flue-sheet—a work which it performs more precisely and rapidly than is possible by hand. The operator can turn the machine in any direction, and can adjust it to suit the nature of the work in hand, without leaving his place. The construction and application of the machine are illustrated in Figs. 1 to 4.

The boring-arm is received by two opposite, longitudinal slits in a vertical post, pivoted at its lower extremity on a base plate, and secured at its upper extremity to a bearing-block fastened to a strong beam. The horizontal shaft of a driving-pulley extends through the block and imparts its motion to a vertical shaft passing through the post, by means of bevel gears. The horizontal shaft extending through the boring-arm, is likewise connected with the vertical shaft by bevel-gears. To adjust the boring-arm horizontally, a worm-gear at the foot of the post is provided, driven by a hand-wheel. The worm can be readily thrown out of gear, so that the boring-arm can be swung through large angles by hand.

The boring-arm is vertically adjusted by a screw-spindle in the lower portion of the post, the upper end of the spindle carrying a cross-piece which embraces the post and which serves to guide the boring-arm. The spindle can be forced through an aperture in the base plate, deep into the ground. A bevel-gear on the base-plate drives the spindle, the shaft of which gear carries a pulley on its outer end, connected by a belt with a fast and loose pulley on the upper end of the post. The boring-arm is raised or lowered as the fast and loose pulley turns to the right or to the left. But by these means, the boring-arm is only roughly adjusted. A finer adjustment is secured by a hand-driven bevel-gear on the upper end of the spindle.

The boring-arm can be moved longitudinally by mechanical means. The shaft within the boring-arm is given the form of a screw-spindle, which can be held in adjusted position by means of a tongue and groove, a clutch in the form of a half-nut being used to throw the spindle into and out of gear. For the fine adjustment of the boring-arm, a hand operated device is used, consisting of a toothed wheel engaged by the grooves in the neck of the boring-head and turned by means of a ratchet. The boring-head can be rotated and locked by means of a small worm-gear.

If it be so desired the automatic means for adjusting the boring-head can be dispensed with, and the head operated by means of a hand-wheel. Under these circumstances the driving-pulleys and belt are discarded, together with the two pairs of bevel-gears, so that the boring-arm is raised and lowered by means of a hand-wheel, through the medium of the shaft below the boring-arm. Instead of the screw-spindle in the boring-arm, an ordinary shaft is used to rotate the boring-head. The boring-arm is coarsely adjusted by moving it manually through the cross-piece. All finer adjustments are made as in the manner previously described.

If it be so desired the machine can be electrically driven, in which case the construction is changed in some details, without however, changing the principle of the invention.

The boring spindle, *D*, (Fig. 5) passing through the cross-piece, *B*, is directly connected with the electric motor, *E*. The boring arm is raised and lowered by means of the screw-spindle, *C*, driven by bevel-gears, *H H* (Fig. 6), and thrown into gear with the spindle by means of the clutch, *C'*. For the finer adjustments, a hand-driven sprocket and chain are employed. To the left of Fig. 6, the half-nut previously mentioned can be seen, by means of which the boring-arm is coarsely adjusted. The nut is thrown in and out, in the same manner as the hexagonal clutch, and is shown in Fig. 7.

It may sometimes be desirable to run the machine to a boiler instead of bringing the boiler to the machine. Under such circumstances the boring machine is mounted on wheels, as shown in Fig. 5, by reason of which arrangement the post, to a certain extent, can be adjusted laterally, i. e., perpendicularly to the track.

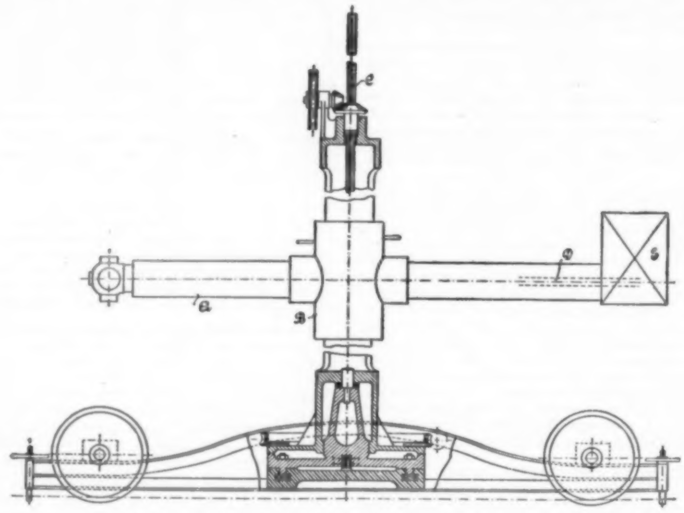


FIG. 5.—BORING MACHINE DRIVEN BY ELECTRIC POWER.

RAILS.

INASMUCH as there has not been time for concerted committee work, the committee, as a body, should not be held responsible for the report herewith presented.

The railroad mileage of this country at end of 1898 is reported at 187,000 miles, with 245,000 miles of track. The expenditure in 1896, on account of maintenance of way and structures is given as $160,000,000, about 21 per cent. of all operating expenses. The expenditure on account of rail based on figures for past five years would be about $14,000,000. This does not represent the amount paid mills for new rails, as that amount is credited by amounts received from sale of scrap and old rail applied to construction of sidings, etc. It would appear fair to estimate that about $25,000,000 is paid out per year to the rail mills by our railroads.

A glance over the maintenance of way and structures accounts indicates that expenditures on account of rails come second to cross-ties, and taking into consideration the large amount involved, and increase of one year in the life of our rail means a considerable saving. On account of the sharp competition for traffic, low rates and the necessity of bringing down the transportation expenses to meet the constantly decreasing rates, the rail question may be considered to be one of prime importance.

It is a duty of the engineer to use such materials as shall be economical both in original cost and maintenance. The two items of original cost and maintenance are very closely related. If we now pay $33 for a rail lasting, say, ten years, it is costing us $3.30 per year; if

* Committee Report presented to Annual Convention American Railway Engineering and Maintenance of Way Association, Chicago, March 15, 1900.—From The Railway Age.

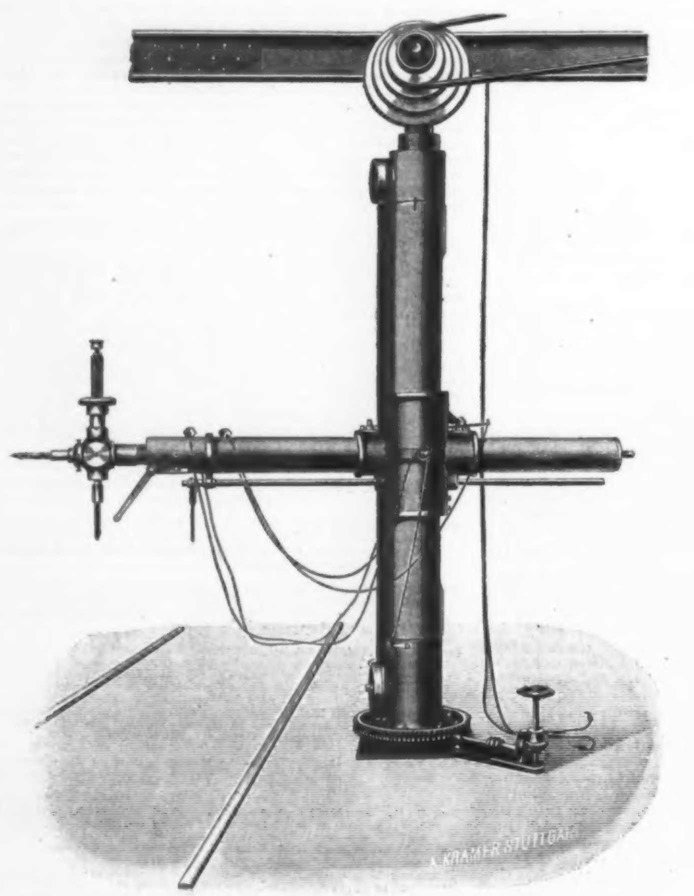


FIG. 1.—LANGBEIN BORING AND TAPPING MACHINE.

FIG. 2.—DRILLING BOLT-HOLES IN EXTERIOR OF A LOCOMOTIVE FIRE-BOX.

by paying $34 we could get a rail that would last eleven years, it would cost us $3.10 per year—a saving we could well afford to make. So we see that there is possibly no problem worthy of more attention than the one of economical wear and service of steel rails.

This committee has received a communication from a member in Canada, unable to be present, asking and, we might very properly say, imploring the help of your association toward securing better rail. His railroad is buying from the States; the rail is soft and wearing badly. The mills have been asked to give better rail and the reply is that the railroads in the United States are using the same rail, and what is good enough for the States is good enough for Canada, and here endeth the first lesson. Your committee is also of the same opinion as the mills "that rails good enough for the States is good enough for our brother in Canada." Do not our trains run as fast, and are not our engine and car loads as heavy? And this brings the issue squarely before us:—Is the rail now furnished by the mills of the States good enough for the railroads of the States? If this committee could conscientiously answer yes, then it might congratulate itself on having an easy life ahead. We cannot, however, concede the truth of the statement, that the rail we are now getting is good enough, and we will, therefore, aim to make such practical suggestions or recommendations as shall help toward a solution of this vexatious problem.

It may not be out of place to call attention to the fact that many well meaning efforts at reform have been in vain on account of the very radical position taken by some of the persons connected therewith. Therefore, if any of us incline to extreme views in such matters as high carbon, or low carbon, let us find at least some common ground on which we can take a stand and then we shall make headway, possibly slowly, but surely. If we agree on uniform sections for all our lines we will eventually save for our companies, and possibly, in addition, increase the profits of the rail manufacturers, about which so much talk has been heard in Pittsburg recently. Let us agree on one other thing—that the mechanical treatment in rolling and the temperature at which the rail is finished is of the greatest importance—then insist on the mills making an improvement in this regard.

If this association can agree on a specification for the manufacture of rail, which may not be perfect, but which will be a step in advance of what we are doing, have it approved by our companies, and accepted by the rail manufacturers, decided progress will have been accomplished. It would appear better that we should attain our goal by making two or three steps, if necessary, as we are able, rather than by trying a big jump and fail.

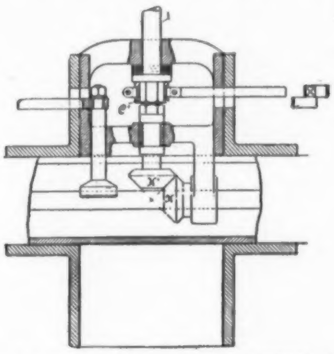
The committee deems it proper in this preliminary report to give a brief resume of the facts in regard to evolution of our present rail. It is said that railways are as old as civilization, reference being had to ways adapted to the passage of wheeled vehicles. Wagons were used in Egypt at a very early day. No doubt railways were used in the construction of the Egyptian pyramids. Wooden railways are said to have been used in the mining districts of Germany from time immemorial; they were introduced into England as early as 1602, and to this country we are largely indebted for the development that has taken place.

The wooden tramway was the first improvement over the ordinary road.

1602.—In a history of coal mining at Newcastle-on-the-Tyne we find a complaint of "badness of the roads by which the loads of carts were reduced."

1649.—On the authority of Nicholas Wood, who mentions a book entitled "Chorographia, or a Survey of New Castle-upon-Tyne," published in 1649, credit is given to a South County man named Beaumont, who introduced wagons which ran on tramways. We are told Mr. Beaumont expended £30,000 in improving ways and wagons, etc.

1676.—Roger North, in Life of Lord Keeper North, vol. 1, p. 265, states that at Newcastle-on-the-Tyne in 1678, among the curiosities of the place were "Way Leaves" or "Ground Let for Laying Wooden Tramways On." These consisted of single wooden rails of timber, straight and parallel.



FIGS. 6 AND 7.—HALF-NUT, CLUTCH, AND BEVEL GEARS.

1700.—Double wooden rails used, that is, a second longitudinal was spiked on top of first stringer.

1737.—Cast-iron plates used on face of wooden rail to obviate rapid wear.

1750.—Cast-iron wheels in use.

1765.—We hear of regular constructed railways, with special works cutting and filling, with wooden rails 7 inches square, resting on cross sleepers 4 feet apart.

1767.—Cast-iron rails first made at Colebrookdale Works in Shropshire, 5 feet long, 4 inches wide, and 1¼ inches thick, each rail having three holes to fasten. Mr. Nicholas Wood, in his book on railroads, 1825 edition, says: "Mr. R. Stephenson, whose inquiries with railroad conveyances have been pretty extensive, states: 'I some years ago visited the great iron works of Colebrookdale, in Shropshire, where cast-iron was indisputably first applied to the construction of bridges, and, according to the information which I have been able to obtain, it was here also that railways of that material were first constructed. It appears, from the books of the extensive and long established company, that between five and six tons of rails were cast on the 13th of November, 1767, as an experiment, on the suggestion of Mr. Reynolds, one of the partners.'"

1770.—Wooden rails have rounded tops, with wheels cast-iron hollow to fit. Outer flanges rejected.

1776.—Cast-iron railway at Sheffield, two flanges projecting upwards; both flanges of wheel dispensed with.

1789.—An organic change, comes with the Jessop edge rail, so-called from being narrow and deep, which again restored inside flange. They were cast-iron bars 3 feet to 4 feet long, web ½ inch to ¾ inch thick, swelling out at head to 2 or 2½ inches.

1792.—Chairs for rails appear.

1797.—Plate rail with flange turned up like an angle, later improved with fish belly.

1800.—To this date the rails were laid longitudinal on cross sleepers at intervals of 3 to 5 feet. Ostram used stone sleepers instead of wood cross-ties, giving name Ostram roads, after abbreviated tram roads.

1803.—The Surrey Iron Railway, the rails were 3 feet 2 inches long, rectangular plates of cast-iron 4 inches broad on the tread, 1 inch thick, except for 5 inches or 6 inches at each end, where they were ½ inch thick; below was a rib or fish-belly about 2 feet long for additional strength.

1808.—Malleable iron used at Walbottle Colliery, near Newcastle—one hundred and fifty years of engineering experience required to advance from timber, laid down to prevent wheels sinking into the mud, to an iron rail and iron wheels, something like mode of present day.

1811.—Wrought-iron rails in use.

1820.—The Bedlington Iron Works rolled rails 15 feet long after designs by Birkenshaw.

1825.—Stockton & Darlington Railroad opened September. Construction consisted of fish-bellied rails 28 pounds to yard. Points of support 3 feet apart.

1831.—Camden & Amboy partly laid with Stevens rail, commonly known as Viguoles, and the design attributed to this French engineer, who introduced it into England. This rail was rolled by Dowlais Iron Works, Cardiff, Wales, 500 rails 18 feet long, 36 pounds to yard, being shipped to Philadelphia in 1831. This type almost universally used in this country and Europe.

1835.—Experiments by Barlow led to abandonment of fish-bellied rail in England and substitution of rail with parallel faces.

1837.—Double and equal headed reversible rail invented by Joseph Locks and used on Grand Junction Railway.

1844.—First rail rolled in America at Mount Savage, Allegheny County, Maryland. It was U form, 42 pounds weight, laid on longitudinal wood sills.

1856.—First Bessemer rail rolled. The behavior of these first rails was unsatisfactory and manufacture was abandoned.

1864.—Manufacture of Bessemer rails resumed.

1872.—Manufacture of steel rails in United States, largely increased about 1875.

1892.—A. S. C. E. sections adopted by the American Society of Civil Engineers and may we not add

1900.—A. S. C. E. sections adopted by this association.

SECTIONS.

The railways of United Kingdom are almost universally using the bull-headed steel rail, keyed into chairs fastened to transverse sleepers, while in America we use flat-bottomed rails, resting direct on transverse sleepers.

In a paper reported by William Hunt, chief engineer

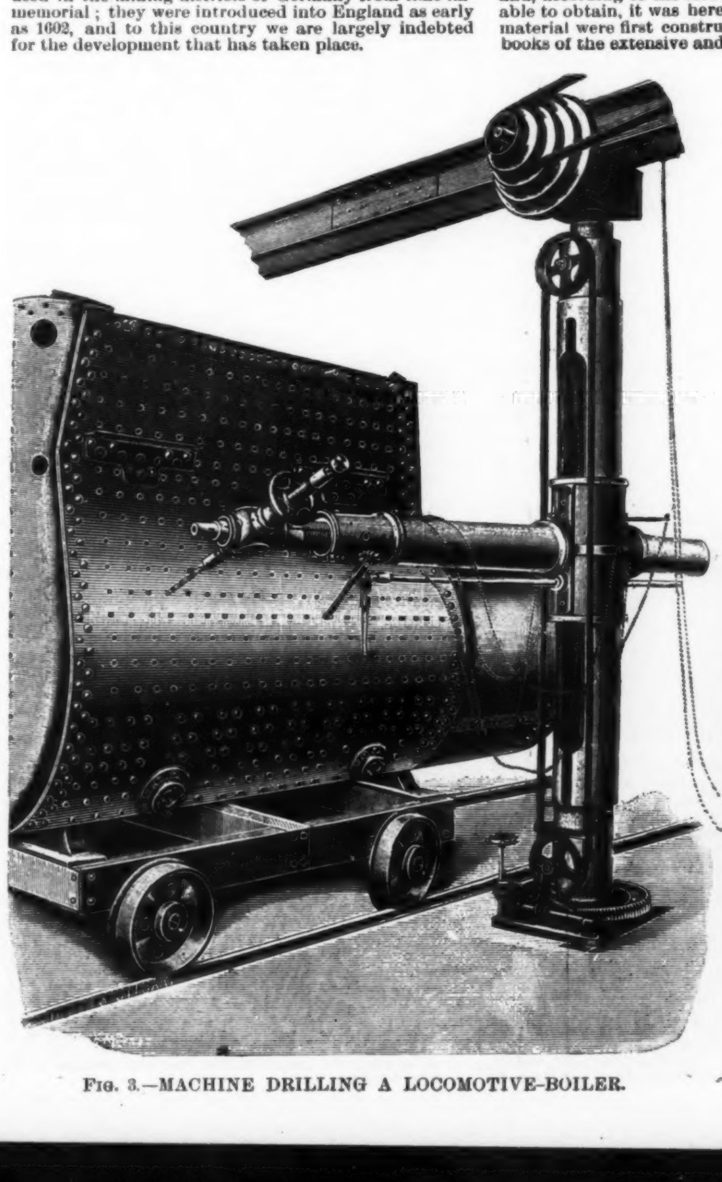


FIG. 3.—MACHINE DRILLING A LOCOMOTIVE-BOILER.

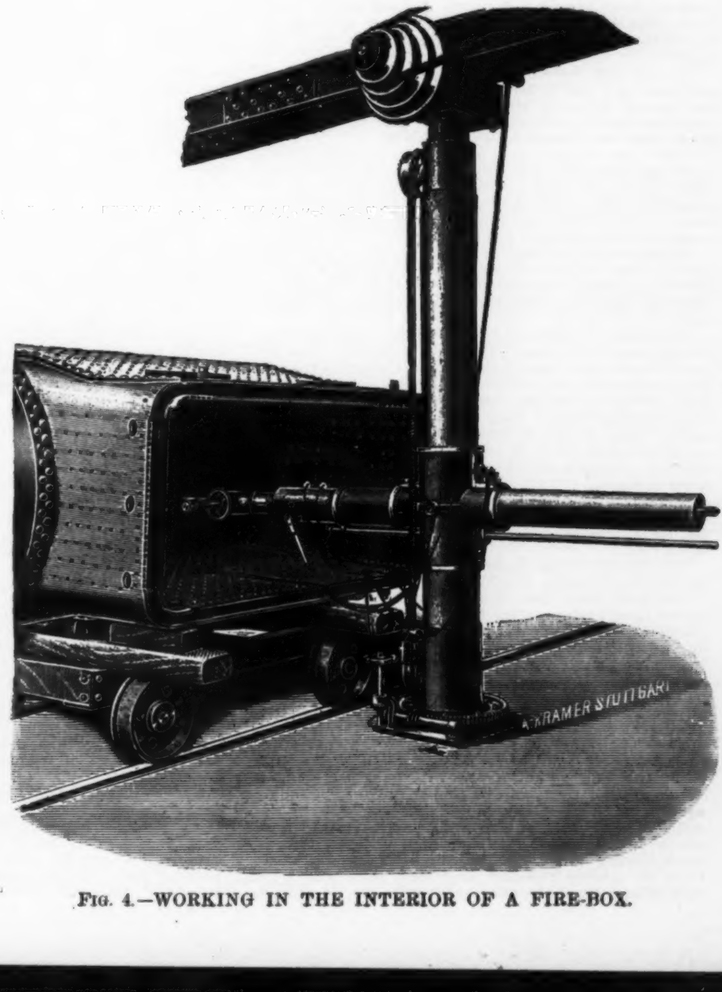


FIG. 4.—WORKING IN THE INTERIOR OF A FIRE-BOX.

of the Lancashire & Yorkshire Railway, read before the International Railway Convention of 1895, we take the following:

"The engineer of the Great Northern Railway of Ireland, comparing our American practice with the English says: 'As the steel rail (American) is immediately in contact with the sleepers, the result is a very smooth running road; at the same time there is no doubt that our steel bull-headed road, with the chairs keyed inside, is far superior, stronger, more permanent, and better in every way than any flange railroad.'"

The chief engineer of the N. Y. C. & H. R. R., reporting on the American type to the same body, says: "Rails supported in 'chairs' have been out of date in this country for many years past, the Viguoles type, or 'flange' rail, as it is termed in this country, having proved immeasurably superior in service and economy on American railroads."

The committee being of the opinion that the A. S. C. E. sections are a step in advance, is of the opinion that no new sections should be suggested until we have had full time to learn from experience the merits of these sections. It is recommended that all members of this association whose lines are not using these sections be urged to have them adopted and used on their lines. The results should be carefully compared with results from the old sections. Mr. Manning writes us that "the A. S. C. E. sections are by far the best with the exception that the head should be a little deeper for rails under 90 pounds." Of course, you all know that Mr. Manning has a section of his own for curved track, which he thinks can be applied to straight line also with good results. The percentage of curved tracks on a majority of lines is small, so that in the opinion of a majority of the committee, no additional sections are needed to meet the situation.

Referring again to the A. S. C. E. sections, we must always bear in mind that the best results from these sections will not be obtained until better work is done at the mills, and this brings us to the chemical constituents and the mechanical treatment, the latter being probably the more important.

Chemical Constituents.—Experiments are being conducted on a small scale with open hearth nickel steel, Bessemer nickel steel and high and low carbons. These special rails are very high priced, and in the opinion of the committee are not likely to come into general use at least for some time. We do not consider it advisable to treat this matter at length at this time any more than to call attention to the fact that in many cases of rails giving good service, we have to look beyond the chemical constituents, as we shall see later. Your attention is called to an abstract from The Railroad Gazette, of November 24, 1899, on hard and soft or high and low carbon rails, as follows:

"Quoting the results of experiments on the Netherlands state railroads, in which sixteen German rails were made from four different charges, two of which contained 0·38 carbon and two 0·21 carbon. After 1,833 days' service these rails were reweighed and the loss of weight in the case of the soft rail was 28 per cent. more than in the case of the hard rail. After 3,787 days' service they were again reweighed and found that the hard rails had lost 14 per cent. more than the soft rails, with total results after 5,620 days and 91,459 train movements the soft rails had lost 4 per cent. more than the hard rails.

"In addition to this, twenty-two Belgium rails were laid, made from six different charges, three of which contained 0·45 carbon and three 0·25 carbon. After 2,040 days' service the soft rails had lost 29 per cent. more than the hard rails, but in the next weighing, after 3,635 days' service, the hard rails had lost 5 per cent. more than the soft, with a total result that, after 5,675 days' service and 98,938 train movements, the soft rails had lost 7 per cent. more than the hard.

"In the first reweighing the hard German rails lost, per meter and per 10,000 trains, 133 grammes, while on the second weighing they lost only 91 grammes per meter and per 10,000 trains. In the soft German rails these losses were respectively 170 and 80.

"With the Belgium rails at the first reweighing the hard rails lost 121 grammes per meter and 10,000 trains, while on the second reweighing they had lost 98 grammes. The soft rails had lost 156 grammes per meter and 10,000 trains in the first period and 93 grammes on the second period."

Attention is called also to a paper by one of the members of this committee, Mr. Hunt, some years ago, in which he brought out the fact that rails with widely different chemical components gave equally good service.

Mechanical Treatment.—The rolling of the rail is of the highest importance; the best American rails appear to have been made about 1880; there was then no good uniformity in chemical constituents of Bessemer steel; it varied widely, but such variation had but little influence on the wear of the finished product. In order to determine why the rails gave good service, we must, therefore, look to the methods of manufacture, and the molecular structure of the steel resulting from these methods.

The following description of the old and new methods, with certain deductions, is quoted from a letter of Mr. Reed, in charge of a rail sawing plant at Wheatland, Pa.:

"In 1880 the usual Bessemer practice was as follows: In the blast furnace, ores naturally low in phosphorus and sulphur were used, the iron was produced much slower than to-day; after being cast into pigs, it was allowed to cool (come to rest molecularly), then selected on its chemical analysis, remelted into cupolas, and blown into converters in smaller quantities and also slower than at present, and it is fair to assume was more thoroughly 'cooked' and combined with its alloys. The resulting ingots (14 inches square) were allowed to cool (come to molecular rest), were stripped of their molds, and were then charged into horizontal furnaces, were they were heated much slower than now, and not so hot as present practice compels. When heated they were bloomed down to 7 inches square, in thirteen passes keep in her pass through rolls. These 7-inch blooms were then allowed to cool (come to molecular rest), and then charged into another heating furnace, again being heated more slowly than in present practice, and then were rolled into rails of somewhat less average weight (say, 70 pounds) than at the present time. Using a smaller bloom than now, even though making generally a lighter rail, there was less reduction of work necessary in the rolls, but it was slowly done, as 49 square inches of bloom were reduced to a 70-pound rail in thirteen passes, in a train running 400 feet per minute. As a result of this deliberate and thorough working the steel was never subjected to violence, and was finished cooler, and this had a most salutary effect on its molecular structure.

"Comparing this old practice with that now in use, we find as follows:

"In the blast furnace, ores both high and low in phosphorus are used (i. e., some extremely low and others above the normal, as compensated), and the furnaces are driven at a high rate of speed. The metal, when reduced, is run, fluid, into a 'mixer,' but is never allowed to come to rest or cool. From the mixer it goes still fluid to the converter, and is blown hard and rapidly in less time than before and in larger amount. Then cast into ingots, which are not allowed to cool or come to rest, but are at once charged into heating furnaces and held there until ready for blooming. They are then (with their contents in an unknown state, sometimes fluid, semi-fluid, pasty or granular) passed to the blooming mill and reduced from 16 to 18 inches (an average modern-sized ingot), having 288 square inches of area, to a bloom 8 inches square, having 64 square inches of area, which is a reduction of 224 square inches in eleven passes, or 20·4 square inches of reduction to each pass (instead of 11·3 as formerly), which is nearly 100 per cent. faster, in addition to which the train is nowadays driven at a higher rate of speed than formerly. The 8 by 8 bloom thus produced is not allowed to cool, come to rest, and readjust its outraged and crushed particles, but is charged into a heating furnace and held hot, or in some cases proceeds without further heating direct to the rail mill, where it is reduced to a 70-pound rail in nine passes (instead of 13), by rolls running 900 feet per minute, instead of 400, as formerly, which is over 60 per cent. more rapid reduction, pass for pass, leaving out of consideration the speed at which it is done, which has an important bearing on the final result. Owing to all this haste, the rails finish at a high temperature, and the heads practically anneal and soften themselves on the cooling beds, but the annealing is useless and too late, as the mass of metal in the heads is, of course, open, friable grain, and poorly fitted to stand the abrasice action of car wheels under heavy loads."

When steel is allowed to cool without being subjected to work, it takes on a coarse, crystalline structure. If it is subjected to work while in the plastic state, the crystallization becomes smaller and smaller as the work is done at successively lower temperatures, until we reach the recalescent point.

The main difference between the present and former mill practice in making rails consists in a fewer number of passes and faster speed of train by which the finished pass is reached, while the metal is still at or above an "orange" heat (2,000 to 2,200° F.). Whereas, in the older practice, with more passes and slower speed, it was finished at a "cherry red" heat (1,400 to 1,600° F.). The modern rails, as shown under the microscope, have a crystalline structure in the head, which cools last. The larger the section the slower the cooling and the coarser the crystallization. Rails finished at a dull red heat (1,300°) have a fine granular texture throughout, as shown by experiments made by the Carnegie Steel Company.

It is our opinion that the wearing quality of the rails will be improved by taking more time for the finishing passes at the rolls.

This does not mean that the speed of the rail mill need be reduced, but that provision be made for holding a number of rails at a certain stage in the rolling, allowing them to come to a certain temperature, which will also mean that the heat retained in the rails will be distributed uniformly throughout. The rails are then taken in the order in which they have been held, and the finishing passes are taken at a lower temperature than present practice. Your committee understands that patents have been taken out covering this improved method of rolling, and that in the near future we may expect rails with more work on them, insuring a better wearing surface and a better wearing rail.

Length of Rails.—There is probably more diversity of opinion at the present time on this point than any other. We have been advocates of 30-foot, 33-foot, 33-foot 4-inch, 45-foot, and 60-foot rails.

The transportation difficulty has been the governing feature in fixing at 30 or 33 feet, the latter being considered the longest rail that can be handled conveniently in present length of cars. The advocates of 45-foot rail think 45 feet about the maximum length that can be used with reasonable close-joint spacing. Then we have the 60-foot rail, taking out 50 per cent. of our joints.

It is the experience of a part of the committee that 60-foot rails can be laid with most excellent results on lines of easy grades and light curvature, with joints much closer than used in the average practice. It is believed that the best results will be obtained with 60-foot rails when anti-creeping devices are used at least every 30 feet.

The care of rail in laying and after laying, although of very great importance, is possibly second to some of the items mentioned.

Thousands of tons of rail have been taken out of the track after short service on account of battered ends due to improper and wide spacing at joints. If your track is well and full ballasted there is little trouble to be anticipated by laying pretty close joints. If, however, you lay close joints and have your track half or quarter ballasted, look out for bad results in very hot weather.

These matters will receive more attention from the committee at a later time.

Specifications.—The committe will recommend to your association a standard specification for general adoption.

In Conclusion.—The very complete syllabus prepared for the association fully covers the ground, and the committee has nothing to suggest in addition to that syllabus. It notes that there are seven subdivisions, or one for each member of the committee, leaving the chairman and vice-chairman the opportunity of making the ordinary committee members do the work. The committee congratulates itself on having such men as R. W. Hunt and W. T. Manning with it, who can do the work.

R. W. TRIMBLE, Pa., chairman,
S. M. FELTON, C. & A., vice-chairman,
A. W. JOHNSTON, N. Y. C. & St. L., Cleveland, O.,
THOMAS PURCELL, Mex. Nat., Matamoras,
C. A. CARPENTER, L. S. & M. S., Cleveland,
C. E. WICKHAM, C. R. I. & P., Chicago,
R. W. HUNT, Chicago,
J. H. WALLACE, Southern Pacific, San Francisco,
G. B. WOODWORTH, C. M. & St. P., Chicago,
Committee.

PAINTS AND VARNISHES.

By Prof. A. H. SABIN.

[Read before the Boston Society of Civil Engineers, November 15, 1899, and published in the Journal of the Association of Engineering Societies.*]

IRON may be protected from corrosion in several ways. First, by imbedding it in concrete or cement. This material is strongly alkaline, and, as alkalies do not attack iron, the iron is likely to be preserved as long as the alkaline quality persists, which may be for years, especially if in a dry place; but cement is somewhat porous, as may be shown by the fact that a battery cup may be made of it as a substitute for the ordinary porous earthenware cup. It is also well known that there is a German cement-testing machine, which operates by determining the relative porosity of similar plates made of cements. If, then, cement or concrete is used under water or exposed to acid gases, which will attack the alkali in the cement, its porosity, though small, may lessen the duration of its protective effect. If, as a second method, we use a non-porous and insoluble cement, such as asphalt, we avoid this difficulty; but this method also has its limitations. For example, it cannot be used where the material may be subjected to heat, as the asphalt will melt; and, since asphalt is a viscous substance, it will not support itself, but will run off, or may be forced out of place by external pressure. Again, asphalt, which is a soft and flexible substance, owes its pliability to some mineral oily matter which it contains, and in practice those who prepare it for use almost always add to it some heavy mineral oil to increase its viscosity. This softening ingredient, though apparently insoluble and non-volatile, is only relatively so, and when it is gone the remainder of the asphalt is left as a brittle, crumbly substances of no value for the purpose for which it is used. We should, therefore, use a layer of asphalt of considerable thickness, and the ingredients should be selected and mixed by some one having proper knowledge of the subject. Except in very dry situations, and where the air has very little access, it should not be relied on for permanent protection; but there are many cases, such as those of bridge floors, where it may be the best thing available.

Both these classes of cements are, therefore, to be used only in special cases; and for nearly all such purposes we are obliged to use such coatings as are commonly classed together as paints, meaning thereby a substance as little affected as may be by air or water, and which may be spread in a thin film over the surface of the metal. Such a film should be as nearly continuous or non-porous as possible, and its value for the purpose depends on its retaining a non-porous condition for a long time. For example, a piece of metal may be coated by dipping it in melted asphalt at such heat as to secure a thin film. This film will be highly non-porous, and will resist severe acid and alkali tests; but after a brief exposure to the air it will be decomposed, and will then afford no protection, while a film of other material, inferior to it in the beginning, may retain its original degree of continuity for years and be a valuable coating.

Ordinary oil paints consist of linseed oil, sometimes more or less adulterated, mixed by grinding with a pigment, which latter is usually a mineral substance reduced to a fine powder. The object of using a pigment, aside from its color, is threefold:

First. It hardens the film, which will thus better resist abrasion.

Second. It makes it possible to apply a thicker film, which also wears longer.

Third. The particles of pigment tend to fill up the pores which are naturally present in the oil film, and thus the porosity is reduced.

The pigments used for preservative paints are few in number as compared with those used in house or other decorative painting. They may be described briefly as follows:

White Lead.—This is a mixture of lead hydrate and carbonate, and is sometimes sold as a dry pigment; but more frequently as paste white lead, which is nine parts dry pigment ground with one part by weight of raw linseed oil. This may be made into a paint by thinning it with oil, and usually a little turpentine is also added. The object of the latter is not to cheapen it (indeed, at the present time turpentine is worth more than oil), but to make it work more freely under the brush and to increase the proportion of pigment in the film. This is a matter which it is very easy to overdo, and if too much turpentine is added there will not be enough oil to act as cementing material for the pigment, which will then be easily removed. White lead is especially liable to suffer in this way, since it normally takes less oil than any other pigment, and, moreover, it seems to have a natural tendency to combine with the oil. This combination causes the oil to lose its coherence, and then the surface of the paint easily rubs off. As painters say, it chalks. No doubt a great deal of the bad name of white lead is due to this excessive and improper use of turpentine, which is liked by the painter also because it makes the paint much whiter than it is when oil is used, and because it dries rapidly, owing to the volatility of the turpentine.

White zinc is an oxide of zinc, white in color, and it requires more oil than white lead. It is less opaque; its opacity or covering capacity is usually estimated as three-fifths that of white lead. Paint made with it does not readily brush off as a powder, but sometimes seems to come off in flakes. Painters say it peels or scales. It is commonly used mixed with white lead, and the mixture seems to be better than either sub-

* Manuscript received January 11, 1900.—Secretary, Association of Engineering Societies.

stance alone. Paints made with these pigments are frequently, perhaps it may be said commonly, adulterated with other white powdered substances, such as kaolin and barytes, which are not particularly harmful, and whiting or carbonate of lime, which is actively injurious. While dry these substances appear white, but when mixed with oil they seem to be transparent. They are without value as pigments, and must be regarded as adulterants. White lead and white zinc are practically the only white pigments, and must form the basis of all light-colored paints. Other light colors are made by adding some tinting material to them. The principal yellow color is chromate of lead, or chrome yellow. This is a very brilliant color, rather deep in shade, and the pale shades are made by adding white lead. Chrome green is a mixture of chrome yellow and Prussian blue, and is the only green pigment in common use. Prussian blue is a ferrocyanide of iron, dark blue in color. The common light blue pigment is ultramarine blue, an artificial product of complex constitution, the exact composition and preparation of which is a secret. The yellows, greens and blues are not much used in paints for structural work, but this is not the case with red pigments, the most important of which are the oxides of iron. For this purpose the sesquioxide, which is known in mineralogy as hematite, and the hydrated sesquioxide, or limonite, are used. Usually the two are mixed together in various proportions, the pigment being produced by grinding a natural oxide rock, which commonly contains from 10 to 60 per cent. of other mineral matter, commonly silicates.

The color of these oxides varies from bright red to dark brown, the bright shades commonly containing most hydrated oxide and the brown (rarely dark purple) shades being chiefly anhydrous; oxides of a bright purple or maroon tint are, however, hydrated. It is commonly believed that the brown or dark red shades, that is, the anhydrous oxides, are more durable than the others. Some of these oxides are of artificial origin, such as Venetian red, which is a by-product, originally containing some sulphuric acid, to neutralize which it has been saturated with lime; and in consequence the finished pigment contains a large percentage of sulphate of lime, which cannot be regarded as a desirable ingredient. A knowledge of the chemical constituents of an oxide pigment is therefore desirable. A considerable proportion of silica, or of highly acid silicates, is probably not objectionable, especially if the product is nearly anhydrous; but, if there is ground for believing that the silicates themselves are hydrated, they are simply clay, which is objectionable; and if any lime-salts, soluble in water or acid, are present the material is not suited for the purpose. Oxide pigments are particularly open to the criticism of being, in many cases, not finely ground, a most serious objection. Any good paint should be so fine that it feels smooth and even when rubbed on glass or porcelain with a palette knife. The importance of fine grinding is not likely to be overestimated. Ochers, umber and sienna are also classed with the iron oxide pigments, and usually contain a little manganese, which increases the drying qualities of the oil. They also contain various earthy coloring matters. The ochers are yellow in color, and the iron oxide in them is hydrated. They are often used in conjunction with white lead or zinc. Carbon, in one form or another, is the base of all the black pigments. By far the most common of these, as used in structural paints, is graphite. Other black pigments are lampblack (including carbon black) and bone black, the former being produced in many grades, varying in price from 3 or 4 cents to 60 cents per pound. Bone black, which is refuse from the sugar-house black, varies in the percentage of carbon contained, which is usually about 10 or 12 per cent., the remainder being the mineral matter originally present in the bone and containing 3 or 4 per cent. of carbonate, while most of the remainder is phosphate of lime. Lampblack is an absolutely impalpable powder which has a small amount of oily matter in it, and greatly retards the drying of the oil with which it may be mixed. For this reason it is not used by itself, but is added in small quantity to other paints, which it affects by changing their color and probably their durability. For example, it is a common practice to add it to red lead, in order to tone down its brilliant color and also to correct the tendency it has to turn white, due to the conversion of the red oxide of lead into the carbonate.

There yet remains to be described one other important pigment,—red lead. This is entitled to be placed in a class by itself, because it is intermediate between the paints which it resembles in being used mixed with oil, and the cements, which it resembles in its process of solidification. It is, in fact, a powerfully basic substance, and combines chemically with the oil, forming an insoluble, hard, tenacious mass, in which the uncombined particles of the excess of lead oxide are imprisoned. This is what constitutes the protective film when a red lead paint is dry. Red lead is said by chemists to be a mixture of the peroxide and the protoxide of lead, the latter ingredient being the substance known as litharge. The peroxide is believed to be the characteristic ingredient. Red lead is made by a fire process in a suitably constructed furnace, and furnaces of different construction, or even of the same plan but of different dimensions, are said to give different products. At all events, it is well known that commercially pure red lead, composed of nothing but lead and oxygen, contains the peroxide in proportions ranging from 45 to 90 per cent. The correct proportions of peroxide and protoxide for making the best protective film are not known. Doubtless much of the uncertainty attaching to the use of red lead is due to this.

Linseed oil, made from flaxseed, is the liquid part of ordinary oil paints. It is sometimes obtained by treating the seed with naphtha, thus dissolving out the oil, which is separated by distilling off the solvent for use again. Comparatively little oil is made in this way, most of it being made by extraction under pressure. The seed is coarsely ground, is then heated, sometimes by running a jet of live steam into the meal, sometimes by putting the meal into a steam-heated vessel; it is then, by a machine, put into bags and pressed enough to make it take a suitable form, after which these bags are put into a powerful press and the oil is squeezed out. Moisture and other matters are of course mixed with the oil, and these are separated by allowing it to settle; it is at last filtered. This process of purification takes from one to three months, but even after this the oil improves for a long time by standing, during which some foreign matters separate and settle out. If the oil is at all cloudy at ordinary temperatures it is a sign of not being sufficiently aged. Linseed oil possesses, in a higher degree than any other oil, the property of thickening rapidly on exposure to the air. This is not due to evaporation, but the contrary; it absorbs and combines with oxygen from the air, and thus actually increases in weight, though it decreases in bulk. A paint made with raw linseed oil alone will dry so that it may be handled in five or six days, but, as this is a long time, it is thought necessary to treat the oil so that it may dry more quickly; that is, may absorb oxygen more rapidly. Oil so treated is called "boiled oil." It used to be made by heating the oil over a direct fire in a kettle, and with this oil is mixed, by constant stirring, 1 to 3 per cent. of oxide of lead, either litharge or red lead, or both, and a small proportion of oxide of manganese. When the oil reaches a temperature of about 500° F. it dissolves these metallic oxides, entering into chemical combination with them; and, as these have a great attraction for oxygen, the resulting oil, which is much darker in color than it was, has also greatly increased drying powers, and paint made with it will dry in twenty-four hours. The dark color is due partly to the combined metallic substances and partly to heating the oil for a long time. It is believed that much more oil is present than can possibly combine with the small amount of metallic oxides, and that the product is, therefore, composed of a small portion of oil combined with the lead and manganese, dissolved in a large portion of oil, which is unchanged except that it has been darkened by heat. It has, therefore, become the custom of oil manufacturers to cook only a small portion of oil with the lead and manganese, and after these are dissolved they stir the product into a large quantity of raw oil at a heat about that of boiling water. The boiled oil thus made is much paler in color than that made in the old way, and is said to be quite as good in every respect. It probably is fully as good, and very likely better, being more nearly uniform. But oil made in this way varies according to the amount of oxides used, the proportionate parts of lead and manganese and the heat employed, so that boiled oil from different makers is always different, varying much more than raw oil does.

The foregoing method is the one used by the large manufacturers, but the smaller ones frequently, perhaps it may be said commonly, buy their oxides of lead and manganese already combined with just enough oil to make a compound; about four pounds of oxide of lead will combine with a gallon of oil, but the product in this case will be a solid cake. In order to liquefy this it is common to dissolve it in about two and a half gallons of turpentine or benzine (or a mixture of the two), and this solution, which is a good example of what is called a "drier," and which measures less than four gallons, contains enough metallic compound to go into about fifty gallons of oil, which is the contents of a barrel. So the small manufacturer or dealer opens a barrel of raw oil, takes out four or five gallons, fills it up with this drier, which he has purchased from some one who makes a specialty of it, closes the barrel and, after rolling it about a little to mix it, sells it for boiled oil. Such oil is said to be boiled through the bung-hole, and is spoken of disrespectfully by the large manufacturers; but those who follow this practice claim that such oil is in every way equal to that made in a kettle, while it is much paler in color. It is to be observed that the turpentine or benzine employed is volatile, and to the extent to which it is used "extends" the oil. Benzine is much cheaper than oil, but turpentine is not. A still further step consists in the substitution by the makers of driers of rosin or rosin oil for linseed oil. These are found to combine with the lead and manganese oxides even more readily than linseed oil does, and they cost only from a tenth to a fifth as much. Driers made with rosin and benzine are much less expensive than oil. The temptation is to add them in excessive quantity, and this is not uncommonly done. Such a practice is highly injurious, partly because oil thus diluted makes a thinner and less substantial film, partly because an excessive amount of driers make the film much less durable, and partly because it is generally agreed by experts that rosin is an injurious addition to oil. From a consideration of the foregoing it will appear that, while raw oil is a definite substance, boiled oil is a name applied to a large variety of manufactured products. It is also possible to make boiled oil from fish oil or other cheap oils, and these are not infrequently used to adulterate boiled linseed oil. Heavy mineral oil, such as may be purchased at one-fourth to one-half the price of linseed oil, is also used in this way. These latter practices of systematic adulteration are especially followed by the manufacturers of paints. They take the ground that the users of paint ought to pay a fair and legitimate price for linseed oil paints, and that if they prefer to purchase at a lower price it is the business of the paint manufacturer to make, at a reasonable profit, a paint which meets their requirements. It requires a tedious and expensive chemical analysis to detect these adulterations in mixed paint, and those who try to economise by buying paint below its market value are not likely to resort to such means.

The oil, variously compounded or mixed with these driers and solvents, is mixed with the finely-powered pigment in a mixer, which is usually a cylindrical vessel provided with a revolving stirrer. The pigment has previously been ground dry to such a degree of fineness that most of it will pass through a sieve having a mesh of 100 to 200 to the linear inch. Usually it is not actually bolted, but that is about the degree of fineness which is desirable. The sharper and harder substances should be the more finely powdered. It is common to put the paint thus mixed on the market in this condition as it comes from the mixer, but the more approved practice is to take it from the mixer to a burr-stone mill and to grind the paint through the mill, thus securing a more intimate mixture and breaking up all little lumps. This grinding adds materially to the cost of the paint, and it is probably not commonly done with cheap paints intended for structural metal, since it is impracticable for an expert to take a well-mixed sample of paint and to declare, under oath, that it has not been ground.

What is meant commercially by a pure raw oil paint is made by mixing or grinding a pigment in pure raw linseed oil to which has been added enough drier to make it dry hard enough to handle in twenty-four hours, and containing enough turpentine to amount to from 5 to 15 per cent. of the oil. This turpentine is added in order to make the paint work more freely under the brush, and also because it is the belief of the paintmaker that it is impracticable to otherwise add as much pigment to the given amount of oil as is necessary for the greatest durability of the product. It is by diluting the oil and lessening its amount in the film that turpentine acts as a drier. It does not itself promote in any great degree the oxidation of the oil, but by lessening the amount of oil it correspondingly lessens the need of metallic oxide driers. Turpentine is added for technical purposes, not for economy, and it is often more expensive than oil. On the other hand, the use of benzine is always dictated by a desire to save money. In other respects it is objectionable. Kerosene has also been very widely used as a substitute for turpentine, but does not enter into any first-class products.

Varnishes.—Linseed oil is also used in the manufacture of varnishes, which are used as protective coatings, either alone or mixed with pigment. The other ingredients of varnishes are various resins, which give hardness and luster, and turpentine, which again acts as a solvent and is not in any considerable degree a part of the final permanent film, though it does oxidize somewhat, and doubtless a small part of it remains behind while the major portion evaporates. The varnish resins are of vegetable origin, having exuded, as spruce gum does, from the trunks of trees; and in some few cases these lumps of resin are detached from the living tree and sold for use. Such are called "recent" resins, and the most common one is what is called "manila," and comes from the East Indies. More often the resins are not suitable for the varnish maker until they have acquired considerable age. The tree to which the lumps of resin are attached died and fell to the ground and decayed; the resin became gradually buried in the earth; its volatile part escaped; it became hard and brittle. In this state it is found by the natives, who dig it up and sell it to the local trader, and it becomes an article of merchandise. Such are called "fossil resins;" they are of many sorts, and are found at many places, especially in the tropics. Africa, South America, and especially New Zealand, are great sources of supply. These varnish resins are commercially spoken of as gums, but differ from true gums, such as gum arabic, in being insoluble in water. These pieces of resin are carefully cleaned, by scraping and otherwise, and sorted; the paler sorts are more valuable than the darker; not because they are otherwise better, but because they are less common, and people value pale varnishes more than equally good dark ones.

The varnish maker puts a quantity of this resin, usually 100 pounds, into a flat-bottomed copper kettle capable of holding about 150 gallons, which is mounted on a little iron truck, and this kettle is placed over a hot coke fire. In about half an hour the resin has melted, the temperature being from 600° to 900° F., and is found to have lost from 20 to 25 per cent. of its weight, which has gone off as a vapor. In reality, the resin has become decomposed by the intense heat, and what remains in the kettle is one of the products of this decomposition. Immediately the varnish maker takes the kettle from the fire and adds to it some hot linseed oil, the quantity varying from about 30 pounds to sometimes as much as much as 300 pounds. The oil having been slowly added and well stirred in, the kettle is returned to the fire, and its contents are cooked together until combination is effected. If it is desired to produce a hard varnish, with a very brilliant surface, a comparatively small amount of oil is used; but if the varnish is to be highly elastic and durable, a large proportion of oil is necessary. Since one of the most essential qualities of a varnish for any ordinary use is a high degree of luster, while durability is of less account, because most varnishes wear off by use of the articles to which are attached, it will be plain that for the preservation of structural metal work against corrosion an entirely different kind of varnish from those in ordinary use is required.

When the resinous matter and the oil are properly combined, which may take many hours, the kettle is removed from the fire and allowed to cool somewhat, and the contents are then diluted by the addition of an amount, previously found to be suitable, of spirit of turpentine, so that when cold the varnish will flow properly under the brush. Varnish is much more viscid than oil, and it is, therefore, possible to apply it in a thicker film. It is much harder than oil, and, therefore, resists abrasion; and it is much less porous than oil. It, therefore, naturally has by itself in some degree the qualities which we wish to give to oil by the introduction of pigments; and if it be so made and proportioned that it does not contain in itself the elements of dissociation, there can be no question that it is more valuable than oil paint. As a matter of fact, it has for generations been used over paint to protect it from the weather, and no fact is better established than the permanence of a well made varnish. The question naturally arises, Why may we not still further increase this permanence, as we do in the case of an oil film, by the addition of a pigment? If the latter works so well with oil, why may it not with varnish? The fact is that pigments do increase the durability of varnishes for the same reasons and in the same degree that they benefit oil films, and by far the most permanent paints which it is possible to make are made in this way.

These will not, of course, be as brilliant and lustrous as the varnishes alone, the pigment having an opposite effect, but will be far more so than an oil paint, and will be smoother and harder; while if properly made, they will remain sufficiently elastic. Varnishes are sometimes observed to crack and to come off bodily, instead of wearing off from the surface. This is the worst fault a varnish can have, and is due to its being made of unsuitable materials or in an unskillful way. Any considerable amount of common rosin in a varnish will cause this, and it may also be due to other causes. A good varnish, used for the purpose for which it was designed, will not do it. The commonest adulterant of varnish is rosin, which may itself be made into a varnish and mixed in any proportion. A well made rosin varnish has a very brilliant surface, and works fairly well under the brush, but a comparatively small

amount of rosin will simply destroy the durability of the best varnish.

The objection to the use of varnish paints is their cost. From the nature of things, varnish is much more expensive than oil. When one puts so valuable a material as a good varnish into a paint he naturally will insist on putting it through a mill, and when we compare the cost of it with that of an oil paint run through a mixer there will be a striking difference. Suppose it costs twice as much. This would probably be a minimum. The minimum cost of applying any paint will be as much as the price of the oil paint. Then, when the two are applied, they have cost in the proportion of two to three. If the varnish paint will last fifty per cent. longer than the oil paint, it will then be as economical. It is the opinion of the writer that it has been proved by actual use to be more than 100, and in many cases 300, per cent. more lasting.

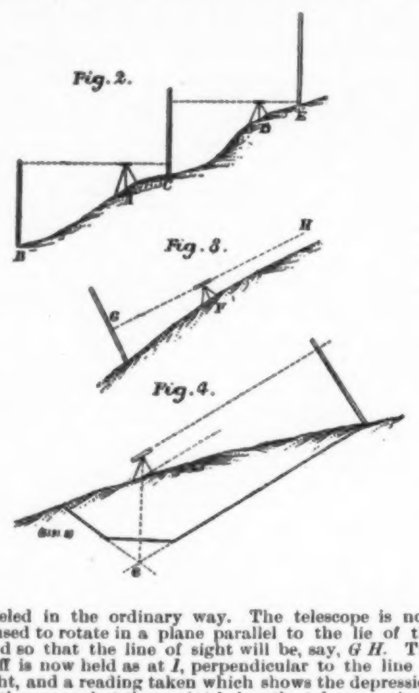
Varnishes are also made which contain asphaltum which is a mineral resin, instead of the vegetable resins already described. These are, of course, black, and they may be made with part vegetable resins and part asphaltum if so desired. The objection to asphaltum is that when used with any considerale proportion of linseed oil its remarkable non-drying qualities make it difficult of use. Its advantage is its cheapness and also its wonderful permanence. When properly combined, however, it is a most valuable material. The simplest way to overcome its effect of preventing the oxidation of oil is to subject the varnished object to the action of hot air. The activity of the oxygen is thus enormously increased, and oxidation proceeds in spite of all obstacles. This is the process known as japanning or enameling, and it has the further advantage that the adhesion of the coating to the metal is much increased, while at the same time the porosity of the coating is reduced almost to nothing. This is because the coating material is kept in a melted or semi-fluid condition while the oxidation is going on, and the pores are destroyed or closed by the flowing of the material itself.

The way this is done is by coating the object, usually by dipping it in the varnish. Then it is put in an oven and baked at a temperature of from 200° to 400° F. for several hours. Sometimes several coats are thus applied in succession. Varnish paints are sometimes applied in this way, making colored enamels of great beauty and durability. But it is possible to use asphaltum in varnishes which will dry at ordinary temperatures. This is most commonly done by using very little oil; also by a large amount of driers, but better by mixing a varnish of asphaltum with one made of other resins. It is also possible to make a varnish containing a considerable amount of asphaltum which will dry reasonably well by great care and skill in its fabrication. It may safely be said that asphaltum is one of the most difficult substances to use, and that while excellent results are obtainable, they are more difficult to obtain than with any other substance, and that bad results are very common.

In conclusion, it remains to be observed that while nothing is here said of the importance of methods to be employed in cleaning the metallic surface, this is not because it is a matter of minor importance. On the contrary, it is of so great importance that a separate discussion of its value and the means of doing it would be necessary, and this paper is, therefore, confined to an account of the materials used. The comparative value of these is difficult to determine, and varies in different cases; but in general the writer has been led to the conclusion that there is not a very decided difference between different pigments in their value for the prevention of corrosion; that varnishes and varnish paints, when made with proper knowledge and skill, are better than oil paints; that these latter give probably better average results than red lead, but that, when the best possible results of red lead are attained, it is considerably better for most exposures than oil paints, and that the use of adulterated materials, either through ignorance or design, is a most serious and common evil. This is rather the fault of the purchaser than of the maker. If the former would not buy, the latter would not make the inferior article. It is within my knowledge that, at the time of writing this, steel frame buildings costing over a million dollars are being erected on which red lead paint is specified; the paint to contain 15 pounds of red lead to the gallon, the cost of materials at wholesale being about $1.30. The paint actually used, and guaranteed to pass the inspection, costs the painter 60 cents per gallon. This is not an exceptional case; such things are going on constantly. The purchaser or his agent is to blame, and it is a valid criticism of very many engineers that they are willing to let contracts at prices which, if the undertaking were properly carried out, would entail loss to the contractor. It does not pay to do business with a man who is losing money. The contractors are the men who build these great engineering structures. The engineers do not build them, nor do the capitalists, but it is the men who do the actual work and who make the necessary parts and supplies; and they are entitled to fair pay for their labor and skill and materials supplied; and when they are told that they will not be paid for a good article, they will be likely to supply an inferior one. Since the range of prices, in the case of paints for structural work, is about 400 per cent., it is natural that inferior articles should be often substituted for better ones in this line if they are in any.

LISTER'S INCLINOMETER THEODOLITE.

WE illustrate an improved form of Lister's inclinometer theodolite now being constructed by Mr. W. F. Stanley, of the Great Turnstile, High Holborn, London. Owing to certain peculiarities in its design, the instrument, which is shown complete in Fig. 1, is capable of doing rapidly work which in the ordinary way can only be done in a slow and laborious fashion. For instance, if it is desired to take a cross-section on sidelong ground, as in Fig. 2, the instrument would, in the usual method of working, be placed at *A*, the staff at *B*, and a reading taken. The staff would then be shifted to *C*, and a second reading taken. Next the instrument would be shifted to *D*, and a back sight taken on the staff at *C*, which would then be removed to *E*. On very steep ground many shifts of the instrument are required, while the chaining of the distances between becomes troublesome, as it is necessary to plumb down from the end of the chain. With the new theodolite, however, the work is done as easily as on level ground. To this end the telescope is so arranged that when the instrument has been leveled in the ordinary way this telescope can be made to rotate in a plane inclined at any desired angle to the horizontal. The advantage of this will be readily understood by a reference to Fig. 3. The theodolite is erected at *F*, and



leveled in the ordinary way. The telescope is now caused to rotate in a plane parallel to the lie of the land so that the line of sight will be, say, *G H*. The staff is now held as at *I*, perpendicular to the line of sight, and a reading taken which shows the depression of the ground at that point below the telescope plane. The distances are measured parallel to that plane, so that in ordinary cases it is sufficient to chain along the slope, no plumbing being required. The angle which the line, *G H*, makes with the horizontal is noted, and it then becomes a simple matter to plot the section. It will thus be seen that one setting of the instrument is sufficient to take the levels of the ground on a slope up or down, backward or forward, within the range of distinct vision. Should a hollow be met with, the bottom of which falls so much below the plane of sight that the staff would disappear, its level can be obtained by a simple adjustment. The staff is held at a point where its top is visible on the telescope, and the latter is then adjusted so that its line of sight cuts the staff, say 10 feet lower down. With this new position of the reference plane, the level of the bottom of the hollow can be read. Stadia hairs are fitted so that the instrument man can determine the whole topography of the ground within the range of his telescope, without re-erecting his instrument, and he may get along on occasion with but one assistant. As already stated, it is necessary that the staff should be read when perpendicular to the line or rather plane of sight. The simplest method of insuring this is to simply rock the staff toward the telescope, and book the lowest reading, as is often done in ordinary level work. At the same time, tilting of the staff to right or left is corrected by signals from the instrument man in the usual way. In certain extreme cases a small inclinometer may be fitted to the staff, and set to the same angle as the vertical arc of the theodolite.

The feature of the instrument which permits of the method of working described above consists in the mounting of the telescope on a supplemental axis, at right angles to the ordinary transverse axis. Setting the vertical arc to any desired angle, the telescope can be rotated about this supplemental axis, in which condition its line of sight will sweep over a plane inclined to the horizontal by the amount shown on the vertical arc. When used as an ordinary theodolite the telescope is clamped parallel to this vertical arc. To take a back sight, the telescope is simply turned end for end round the supplementary axis.

In the ordinary method of setting out curves it is, as well known, necessary to repeat several times a comparatively small angle, which in the English system most usually contains an awkward fraction of a degree. The vernier has accordingly to be carefully read at each new setting. To avoid this, a very neat little repeating device has been fitted to the new instrument. This is clearly shown in Fig. 1, and consists of a fork fixed to the edge of the upper parallel plate, between the jaws of which is a lug which can be clamped at will to the lower parallel plate. The amount of motion of this lug can be regulated by a screw. To repeat the deflection angle for a curve, this screw is adjusted so as to limit the play of the lug to an amount corresponding to this angle. Then, at starting, the lug is moved up against one jaw of the fork and clamped there. The upper plate is then released and moved till the other jaw comes in contact with the lug, thus giving the desired deflection angle. To repeat, the parallel plates are clamped, the lug freed and moved forward

FIG. 1.—LISTER'S INCLINOMETER THEODOLITE.

again to the limit of its play, reclamped in its new position, and the top plate moved again as before.

For setting out the side widths of straight cuttings or banks, the instrument is particularly useful. It will be clearly understood that once two slope pegs have been driven, all intermediate ones can be put in without further calculation. To do this the vertical arc of the theodolite is clamped to the angle of the desired slope, and the instrument erected in a position such that the line of sight cuts both the distant and near pegs as it is rotated round its supplemental axis. Then, wherever this line of sight cuts the ground, is a point on the outcrop of the slope of the cutting, no matter how irregular the lie of the ground may be. The position of the two original pegs can be fixed with but little difficulty, as will be seen by a reference to Fig. 4. Thus, if it be desired to set out the slope pegs for a cutting as shown, the instrument is set over the center peg, and the depth of the point at which the slope pegs intersect is calculated. Let this be D and H, the height of the telescope axis above the ground line. The telescope is then set to angle of the slope, and the level staff moved outward till its reading is $(D + H) \sin \theta$ where θ is the angle of the slope. Several slope pegs can be set out in the same way from the one station, so long as the height to be read does not exceed the range of the staff. By setting the vertical arc to the slope for the other bank, the peg there can also be fixed. We are indebted to London Engineering for the description and engraving.

GRINDELIA PATENS.

AT the commencement of last year, says a correspondent of The Gardeners' Chronicle, I received from Mr. Shin, Curator of the Government Botanical Station, at Berkeley, California, the seeds of four species of Grindelia, two of them named G. patens and G. cuneifolia, and two unnamed, and labeled respectively as G. species, and G. species from Fort Bragg. They all came up well, and in appearance and habit of growth the first three are almost similar, the one to the other; but the fourth is much dwarfer, and lower growing, with smaller leaves. Only the first named, as represented in the woodcut, has bloomed as yet; but as the others are growing vigorously, I hope to see them all bloom in the course of next spring or summer. I have sent plants of all four to the Royal Gardens, Kew, for identification. G. patens is a very pretty pale yellow composite.

GRINDELIA PATENS.

MASON BEES.

THE chalicodomæ well merit the name of "mason bees," bestowed upon them by Reaumur before the establishment of the binonical system. In fact, they construct dwellings with genuine mortar that are so strong that it requires the use of an iron instrument to make an incision in them. These nests are established upon stones or, oftener, upon walls having a southern exposure, and somewhat resemble pellets of mud scattered about as if they had been thrown by the wheels of carriages or the feet of horses. The masons are so particular as to the solidity of their habitations that they refrain from attaching them to rough-plastered walls, and take care to construct them upon bare stones rather than upon the cement that binds the latter together. Moreover, for the establishment of their nests, they always select a place where the latter can be most firmly attached, and prefer to build in angles formed by plinths, cornices and entablatures and in the projections of windows.

As noted by Fabricius, the chalicodomæ employ as a building material marl mixed with a little sand and kneaded with their own saliva. Damp places, which would facilitate the exploitation and diminish the amount of saliva used for mixing the mortar, are shunned by the chalicodomæ, which refuse to use fresh earth for building, just as human builders reject decomposed plaster and lime that has been slaked for a long time. Such materials, full of pure humidity, would not set properly. What the insects want is a dry powder which quickly absorbs the disgorged saliva, and, with the albuminous principles of the liquid, forms a sort of Roman cement that quickly hardens—something, in fact, comparable to the cement that is obtained with quicklime and the white of an egg.

The body of the male chalicodomæ is covered with velvety hairs of quite a bright ferraginous red. In the females the hairs are of a beautiful velvety black, and the wings of a handsome dark violet.

The nest building is done by the females alone. They betake themselves to a dry place, prepare some cement, and form therewith a pellet about the size of a rabbit shot, which they carry away between their mandibles to the place selected as the site of their nest. Upon reaching this, they deposit the pellet upon the wall and spread it out into a circular form. They then collect grains of sand or gravel and insert them in the soft mass. In order to effect a saving in labor and mortar, the insects employ coarse sand, the grains of which are to it genuine blocks of hewn stones. Of these it selects such as are very hard and are almost always provided with angles, which, when properly arranged with respect to each other, concur in giving the whole the necessary solidity. Layers of mortar, sparingly interposed, cement the grains together. The exterior of the cell thus assumes the aspect of a piece of rustic architecture in which the stones project with their natural inequalities; but the interior, which requires a smoother surface, so that the tender skin of the insect shall not be injured, is finished with a coat of pure mortar. This internal coating is deposited roughly, and so the worm, after the paste of honey is finished, makes a cocoon for itself and upholsters the rough wall of its dwelling with silk.

After the chalicodomæ has established its pellet of mud, it begins to excavate a small hole in its upper surface, and scrapes the mud away from the center toward the margin by means of its jaws, so that the cavity at length has the form of a thimble. After this cup is finished, the insect abandons its occupation of mason, and proceeds to collect the food necessary for its future progeny.

It is then seen flitting about among the flowers and plunging eagerly into those of the broom, whence it soon makes its exit with its crop filled with honey and its body covered with pollen. As soon as it reaches its cell, it thrusts its head into it, disgorges its honey and then carefully brushes itself so as to cause the pollen to fall into the cavity. After this operation is finished, it is seen to enter the cavity again in order to mix the honey with the pollen and make a very homogeneous paste of it. Then it flies away again in search of more food.

When the cell is half full, the insect deposits an egg therein and immediately proceeds to close the dwelling with a cover of pure mortar, which it constructs progressively from the circumference to the center. Two days suffice to perform this work.

Immediately after this, the mason constructs, directly against the first, a second cell and then a third, and so on up to eight or ten cells. Although these cells are closed on every side, they would, considering the slight thickness of the cover, doubtless soon break into fragments through the heat of summer or be completely demolished by the rains of autumn or frosts of winter, were not some measures taken to prevent it. So the insect takes care not to leave them in this state. After all the cells are finished, it constructs over the entire group a thick cover, which, being formed of a material impervious to water, and also being a poor conductor of heat, protects the whole against dampness, heat and cold.

This material is the usual mortar, that is to say, earth tempered with saliva, but in this case unmixed with grains of sand. It is applied pellet by pellet, until a layer nearly half an inch in thickness is formed upon the mass of cells, which finally disappear completely in the center of the covering. This done, the nest has the form of a dome, equal in size to half of an orange.

The nest just studied is one that has been formed complete in all its parts. Very often, however, when the chalicodomæ meet with an old nest, more or less deteriorated, they are content to repair it and put it in a proper state to receive their progeny.

Such repairs are not of much consequence though, since they consist only in closing up the apertures through which the young of the first architect escaped, and in tearing away the shreds of the cocoon hanging from the wall.

What we have just said relates to the "wall chalicodomæ," which is essentially solitary and even very jealous of its property. Whether it has constructed a nest for itself or has only made over an old one, it wishes to keep it for itself alone, and forcibly drives away any other insect that attempts to take possession of it.

There exists in France another species, of which the habits are slightly different, especially as regards sociability. This is the "Coach-house Chalicodomæ." According to the observations of Fabricius, this species establishes itself by hundreds and often by thousands upon the under surface of the tiles of a coach house or of the eaves of a roof. There is here no true society, with interests in common, but simply a gathering in which each individual works for itself and pays no attention to the others—in fact, a crowd of workers recalling the swarm of a beehive only in number and ardor. The mortar employed is similar to that used by the wall chalicodomæ. It is just as strong and impermeable, but is finer and unmixed with grains of sand. The old nests are utilized in the first place. Every free chamber is restored, supplied with food and sealed up. But the old cells are far from sufficing for the population, which rapidly increases from one year to another. Then, at the surface of the nest, the cells of which are concealed under the old general covering of mortar, other cells are constructed in sufficient number to satisfy the needs of nidification. These are placed horizontally, or nearly so, alongside of each other without any order in their arrangement. Each individual has plenty of elbow room, and builds where he wishes and just as he wishes, on condition that he does not interfere with the work of his neighbors. If he does so interfere, the friends of those interested call him him to order. The cells are, therefore, accumulated at hazard upon a spot where no fellow feeling prevails.

There form is that of a thimble divided in the direction of its axis, and their circumference is completed either by the adjacent cells or by the surface of the old nest. Externally they are corrugated or wrinkled, and exhibit a superposition of knotty-like courses corresponding to the various layers of mortar. Within, the wall is rendered even without being smooth, it being left to the worm to supply afterward the polish that is needed. Each cell, as soon as constructed, is provisioned and walled up. Such work is performed during the greater part of the month of May. Finally, all the eggs are laid, and the bees, without any distinction as to what does or does not belong to them, undertake in common the general covering of the colony. This covering consists of a thick layer of mortar which fills the intervals and rests upon the collection of cells. Finally, the nest in common has the aspect of a wide plaster of dry mud, very irregularly convex, thickest at the center (the starting point of the work), and thinnest at the edges, where there are as yet only cells of a new foundation, and of an extent that is very variable according to the number of workers, and, consequently, according to the age of the first nest founded. Some of these nests are scarcely wider than the hand, while others occupy the greater part of the edge of a roof and are measured by square yards.—For the foregoing particulars and the illustrations, we are indebted to La Nature.

WALL CHALICODOMÆ AND THEIR CONSTRUCTIONS.

At the left is seen a section of a nest showing the internal cells.

BUBONIC PLAGUE IN THE BIBLE.

THE earliest record of bubonic plague has generally been dated 300 B. C. Drs. F. Tidswell and J. A. Dick have, however, according to Nature (March 22), recently brought evidence before the Royal Society of New South Wales to show that the epidemic of 1141 B. C., described in the First Book of Samuel (chaps. iv–vi.), was true bubonic plague. "After the Philistines had captured the Ark of the Covenant and taken it to Ashdod, severe illness broke out among the people. 'The hand of the Lord was heavy upon them of Ashdod, and He destroyed them and smote them with emerods.' The Ark was afterward taken to Ekron, and here again we are told 'There was a deadly destruction throughout all the city . . . and the men that died not were smitten with the emerods, and the cry of the city went up to Heaven.' The word 'emerod' has usually been taken to mean hemorrhoids, but in the revised version of the Old Testament it is stated to mean tumor or plague boil. The epidemic in Philistia occurred at the time of the regular plague

season, and mice are mentioned in connection with it, which furnishes additional evidence that the epidemic was plague, for a connection between the death of rats and plague at Bombay and elsewhere has been clearly established. Taking all the facts into consideration, there appears to be contained in the few chapters of 1 Samuel an account of an epidemic of bubonic plague that occurred more than three thousand years ago, or more than eight hundred years previous to the hitherto accepted historic record."

HYPNOTISM IN MEDICINE.

"UNDOUBTEDLY hypnotism is taking a definite and important place in medical science. The profession is recognizing more and more every year the beneficient possibilities of hypnotism, and the disinclination to acknowledge indebtedness to hypnotic principles is gradually becoming less pronounced."

The speaker was Dr. John D. Quackenbos, formerly adjunct professor of English literature in Columbia University, and this statement was made in response to a question from a Sun reporter as to the extent of the practice of hypnotism in modern medicine. During his professorship at Columbia Dr. Quackenbos was a practising physician, and since his recent resignation from the faculty he has devoted all his time to his practice and to the study of hypnotism of which he has been an earnest advocate as an aid to medical and surgical practice. The study of subliminal consciousnesses evoked from an individual personality by hypnotism has received much attention from him and he was prominently quoted in the newspapers last year for his assertions that many hypnotic subjects recalled various and widely diverse selves when under the influence. He has also declared that he knows of a young woman who, when hypnotized, has the power of clairvoyance, and can describe accurately scenes hundreds of miles away, to which she is transported in spirit. This utterance roused much criticism among medical men.

"When psychology was a less advanced and definite science," he continued, "and the theory of a duplex personality was less commonly accepted, reputable physicians had a feeling that hypnotism savored of charlatanism and was outside the legitimate province of medicine. Even to-day, many physicians distrust the psychological science of mental suggestion and refuse to accept its theories and its results, but the progressive and liberal element in the profession is deeply interested in the experiments with hypnotis as a healing agent, and many of the most prominent physicians in the world are making frequent use of mental suggestion in the treatment of cases. Some of these doctors, yielding to a public prejudice which is merely the result of ignorance and is rapidly lessening as the principles of psychology become more widely known and understood, refrain from admitting their indebtedness to hypnotism and seem ashamed to be found making use of it, but others come out boldly announcing their belief in the power and virtue of the science.

"Constant experiments are being made by medical societies and by individuals, and the result of these experiments with the truths deducible from them are absolutely prodigious. Neurologists find auto and post hypnotic suggestion particularly valuable in their special province, and in all nerve diseases hypnotism can be used with most beneficial results, but its curative power isn't limited to neurasthemia. Leaving the moral possibilities of hypnotism out of the question and keeping strictly to therapeutics, experiment has proved and medical journals have admitted that the subliminal or automatic mind, which lies back of the objective personality, can directly influence many of the vital processes, the circulation, the digestive functions, etc. That is, the automatic mind can control the outgo of nervous force to vital organs. In addition to this, hypnotic suggestion can put the mind into a cheerful optimistic attitude toward the disease. The treatment is usually supplemented with auto-suggestion, which might be called self-hypnotism. An objective consciousness can suggest so forcibly to its own subjective consciousness that it will itself be swayed in turn by the subjective consciousness which it has impressed. Does that sound formidable? It is intelligible enough if you once admit the duplex personality, and one must soon admit that, if he studies psychology. To use a commonplace illustration every merchant in the town is unwittingly availing himself of the phenomena of auto-suggestion. He puts in his windows a display calculated to appeal to the senses. This display does appeal to the senses, to the objective consciousness, which immediately goes to work upon the subjective consciousness and impressed it with the desirability of the article for which probably the person has no real need or use. Then comes the reflex influence, and the automatic or subjective mind persuades the objective consciousness to buy. That's a very weak and unimportant illustration, but apply the principle to more serious things and you can see its value. Faith in a doctor or healer of any kind inspires auto-suggestion, and so is an important factor in the recovery of health. Christian science, faith cure, magnetic healing, and the rest of the healing cults are all based on this scientific principle of auto-suggestion, and owe to it all their power. Auto-suggestion I consider the greatest miracle of the mind, and its possibilities for good are simply tremendous. It's a pity that every one doesn't know its value and cultivate it. The state just preceding sleep at night is the best time for experiment. Impress firmly upon your subjective mind then that you will waken without headache and feeling cheerful, and the chances are that you will do so. Repetition might after might of a certain resolve, concerning moral or mental or physical condition will do wonders toward bringing about the desired moral, mental, or physical result.

"Now, the physicians recognize the value of this auto-suggestion, and employ the principle within rational limits. Auto and post-hypnotic suggestion are used by reputable physicians always with reference to what is practical and possible as well as to what is desirable, and never for deceiving the patient and inspiring faith in the impossible through persuasion of the unconscious self that miracles are not out of date. That is where the medical profession differs from Christian Science. The basis of Christian Science is the principle of auto-suggestion, but the Christian scientist has the effrontery to promise the impossible as well as the possible. No conscientious physician pledges the impossible to any patient in the hope of temporarily elevating the physical or mental condition of the patient with a view to obscuring the inevitable end. To do so would be immoral.

"How far, then, can the conscientious physician make use of hypnotic phenomena?" asked the reporter.

"I know of no authenticated case where a so-called incurable disease—that is, organic disease—involving anatomical alteration, dissolution of tissues, has been cured by mental suggestion. Such cases have been reported by healers of one sort or another, but I've not found irrefutable proof of them. If such a case were cured, it would be a definite miracle and setting aside of natural scientific laws, but any functional disease might be cured by faith—that is, by mental suggestion, without any pretence of miracle. It is, I believe, and I think all reputable physicians practising hypnotism agree with me, the duty of the suggestionist to represent to a sufferer from organic disease, the benefits that may reasonably be expected from the application of hypno-science. These benefits one might class under three heads.

"1. The control of nervous symptoms through redistribution of nerve energy.

"2. The establishment of functional harmony and inducing of sleep.

"3. The intensification of normal powers of endurance and resignation.

"These things, the physician may promise, but no miraculous cure. The responsibility of accepting or declining treatment by suggestion as thus explained must rest with the patient."

"What about the possibilities of hypnotism in the treatment of insanity, Dr. Quackenbos?"

"We hardly like to express conclusions on that subject as yet. We are really only at the first of mental science, you know. In cases of neurasthenic mania, fixed delusion or hallucination, resulting from nerve disorder, mental suggestion can unquestionably accomplish remarkable results, but when the line is crossed to permanent insanity and mental defect the possibilities of hypnotic science are not yet definitely known, and cures may be impossible. Incipient insanity may certainly be cured, and suggestion is specially valuable in cases where patients believe themselves predestined victims of hereditary insanity. The fear and anxiety can be removed and consequently the danger of insanity greatly lessened or done away with. Many fixed delusions equivalent to insanity and tolerably sure to lead to serious mental aberration may be by hypnotic treatment held in abeyance for a certain time, and by repetition of treatment and continued freedom from the hallucination the nerves and brain may regain their balance. Sometimes a hullucination can by ten minutes' treatment be permanently removed. The outsider who doesn't study medical records and psychological phenomena would be astonished if he could know how many persons are hag-ridden by some persistent hallucination, and if he could hear an account of these haunting delusions. Often the patient knows that the thing is a hallucination, struggles against it, does not logically believe in its terrors, and yet cannot escape from the persecution. Scores of patients come to me in such condition. Just now I have rather a stubborn case of the sort. A woman came to me in such a pitiable nervous condition because she constantly heard voices through a telephone. She knew that the voices were not real, but she could not escape from them. They buzzed at her ear constantly and drove her wild. Hypnotism is curing her. But, as I said, suggestion probably has its sharply defined limitations in cases of insanity, and probably will be powerless in certain mental conditions.

"I spoke of incipient insanity and a patient's fear of it. The same is true of incipient tuberculosis. Suggestion cannot restore lung tissue; but it can check incipient tuberculosis and neutralize predisposition toward that disease. As far back as 1839, a Paris physician of note treated two girls for incipient tuberculosis. They thought themselves doomed. So did their friends. They were kept under hypnotic influence for three months and were permanently cured. By the way, that is an interesting fact; for no such duration of hypnotic influence is achieved in this day. Recently in Stockholm a nervous prostration case was kept under hypnotic influence for six weeks, and the fact excited much comment and was hailed as a great step in advance.

"Singers use hypnotic suggestion a great deal for throat trouble. Of course it will not promptly, in a single treatment, cure a violent sore throat or bronchitis; but it will remedy any flaw in the voice due to nervous trouble, exhaustion, etc. Actresses also resort to suggestion, often when they are over-tired and threatened with nerve collapse. They take the treatment, too, for self confidence and inspiration; but there we are getting around to the moral issues of hypnotism. That's another story and a much more interesting one. I'll tell you one medical problem of hypnotism which interests scientific men, and a solution of which seems to me altogether possible, although I know of no definite experiment that has proved the possibility. Here is the problem: Can hypnotic suggestion prevent the dimming of the mental faculties and the loss of nerve serenity usually attendant upon extreme age? Why not? I cannot believe that God intended man to grow old as he does. His hold on life may weaken, but his mind should be unharmed and he should live, a comfort to himself and to his friends, until his hour comes. Now, can hypnotic suggestion check the diminution of the brain cells and make possible that euthanasia—sweet dying—of which the Greeks wrote? I do not see any scientific objection, and I have an elderly woman patient now who believes that thing possible and wants to try it. So if we both hold out for a good while and circumstances do not interfere with the treatment that theory will be tested."

"Hasn't quackery increased greatly with the development of psychological science?" the reporter asked, and Dr. Quackenbos's genial face took on an expression of unutterable disgust.

"The country is full of it," he said, with a touch of anger in his tone. "It's enough to make a conscientious scientist weep, or swear, to see the way in which fakirs are gulling the public. The worst of the popular systems of charlatanism is that they are founded on scientific truth, and a half truth is more dangerous than a whole lie. The principle of auto-suggestion is used as the basis for innumerable fakes, and because that one scientific principle leaves the lump of quackery enough to achieve certain good results, the whole lump of absurdity is accepted as truth. Hypnotists advertise that they can work almost any miracle at low rates, gain good business positions for patients, rich husbands or wives, social position, and love. These unprincipled hypnotists have only ignoble aims, but the public is easily impressed. Hypnotism, like every great power, has its possibilities for good and evil. The latter are not nearly so great as the uninformed would believe. Except in rare cases, it is impossible to make a subject do, under suggestion, a thing that would shock and pain her moral nature in her normal state. I never experiment in that field, and disapprove of it, but experiments have been made by reputable scientists, and the conclusions drawn are that, except in cases of great moral obliquity, a suggestion to crime or evil of any kind fails to find response. A person who would commit the crime in his normal state might commit it under suggestion.

"The chief danger in hypnotism lies in the possibility of the impression of low ideals upon the patient's subliminal consciousness, if the hypnotist is himself a man of low and sensual ideals, and the consequent injury to the general character. The practice of hypnotism should, by law, be confined to reputable and skilled practitioners; but, with that precaution taken, the possibilities of evil from hypnotism would be practically nil. You would laugh, though, if you could hear the demands upon my skill made by some persons whose ideas of the science are gained from the advertisements of the quacks. A woman came to me last week and said she needed money and that she wanted me to give her power to collect some bad debts. That's the idea ignorant people have of the uses of what I believe the greatest power for good ever put into the hands of man. I told the woman I was no magician and that I couldn't do anything to help her unless she'd bring the debtors to me. I might hypnotize them into paying, but I couldn't hypnotize her into collecting.

"The various absent-treatment schemes are remunerative frauds. You would be surprised to know how much of that sort of thing is done. A healer advertises, a would-be patient responds and pays the required fee. She is notified that at certain hours the healer will treat her. She is foolish enough to believe it and her faith, or auto-suggestion, gets in its work; so she really does have treatment, and may improve, but she does the work herself, and, save as he appeals to her credulity, the healer has nothing whatever to do with the affair. The various liquor and morphine cures of the Keeley type come in the same category of auto-suggestion cures. The medical profession knows that there's no drug that destroys the desire for liquor, but auto and post-hypnotic suggestions can do it; and if injecting Croton water into a drunkard's arm helps his objective consciousness to impress his subliminal consciousness, and he hypnotizes himself into sanity, there's no harm done, but it's quackery all the same. Patent medicines, in most cases, win their following by the same means. Some of them are medicinally valuable. Many are of absolutely no medicinal value; but, if the man who takes them has faith in them, and his disease isn't organic, they may help him.

"Then there is the whole tribe of magnetic healers, faith healers, etc. Many of them are sincere, but deceived. Others are deliberate charlatans, not because they do not often cure, but because they pretend to be able to perform the scientifically impossible, and do not credit the actual results obtained to their real source, because they ascribe to the supernatural what is a simple scientific fact, as definite and intelligible as telegraphy. There is nothing occult or mysterious about reputable hypnotic practice, and physicians have a right to employ a knowledge of the natural laws governing the mind as well as those governing the body. There is no more reason that a physician should look askance at hypnotists than that he should taboo anæsthetics and disregard the law of circulation.

"Innumerable persons are having their sight much improved by plain window glass, plus suggestion. They believe their spectacles have been fitted to their eyes, and their automatic minds control the nerves of their eyes and work cures. It is quite possible, as the Christian Scientists would say, to demonstrate oversight; but even the head of that cult finds it impossible to demonstrate over-decayed, disintegrated teeth, without the aid of a professional dentist. Christian Science is the strongest of the latter-day healing cults, and the number of people deceived by its specious and illogical theories is amazing. Through mental suggestion, suggestion from the healer, supplemented by auto-suggestion, it works many cures. If it stopped there it would deserve the respect of scientists; but when it evolves from this scientific principle an irrational and illogical religion, when it pretends to have powers beyond science and natural law, it becomes charlatanism, and should be legally suppressed. Their religion is without logical coherence. Their teachers are not profound and scholarly students of the Scriptures upon which they base their claims. Their founder is inconsistent and, to my certain knowledge, her book when first offered to the publishers, was such a mass of confusion and ignorance that it was considered impossible to edit it into coherence and reason. Yet the one grain of scientific truth underlying Christian Science practice wins credence for the whole system. The Christian Science healer is a sort of spiritual broker on the floor of the celestial exchange who, always for a liberal commission, negotiates between the divine and the human and loves to consider himself on equal footing with Jesus Christ. I know that some men and women, well educated in certain directions, belong to the cult, but they are not broadly educated, and I maintain that Christian Science is the voodooism of the half educated.

"I haven't said anything to you about the moral field for legitimate hypnotism; but I have already said and written a good deal about that. It is there that boundless possibilities for good unroll before the psychologist. Inspiration to high ideals and clean living, reform in vicious criminals, correction of chronic lying, stealing, drinking, gambling, and sensual vice

incentive to study and mental progress—all this and infinitely more is possible to hypnotism. I am convinced of it. But all persons cannot become successful hypnotists. I do not believe that a man of gross and degraded nature and of no broad human sympathy can put himself in the necessary rapport with many natures or can make much impression through hypnotism. Some subjects are not susceptible to hypnotic influence, even when they are willing to submit to it. On the other hand, it is exceedingly difficult to accomplish anything with a subject who does not want to be treated. Compulsory hypnotism is possible, but the power is rare. I do not believe in its use, and would not consent to employ it, save, perhaps, in some extreme cases, at the solicitation of the patient's family and friends, or in the case of a vicious criminal. Hypnotism might play a great part in the tracing of crime. No man should be convicted on confession wrung from him under hypnotic influence; but if he could be forced to confess facts that would serve as clues and make possible the absolute proving of guilt, the practice would be valuable. However, that's a big question; and certainly, in my belief, any man thus incriminating himself should have the benefit of State's evidence, on the theory of a duplex personality. That would tangle up the courts, wouldn't it?"

After hearing Dr. Quackenbos The Sun reporter called upon three of New York's most noted physicians and asked their opinions of the medical status of hypnotism. The three answers were, practically, the same. All the physicians admitted that hypnotism is gaining ground in the profession, and, in the form of mental suggestion, without somnambulism, is much used. They, however, laid greater stress upon the dangers of the science and thought that it should be resorted to only when other medical expedients proved useless, and when the case seemed positively to demand treatment by suggestion. To a certain extent mental suggestion is used by physicians in every case, but definite hypnotism may tend to weaken the individuality of the patient. It is to be handled very carefully, and its use should certainly be strictly regulated by law.—New York Sun.

APPARATUS FOR LIGHTING AND EXTINGUISHING GAS FROM A DISTANCE.

APPARATUS designed for lighting gas from a distance by means of electricity are often provided with a platinum wire which the current raises to a red heat, and which causes the ignition. This permits of simplifying the construction, but necessitates the use of quite a strong current, the intensity of which must be so regulated that the wire shall become very hot, but not sufficiently so as to melt. This is a delicate matter that it has been the inventor's desire to avoid in the apparatus represented in the accompanying figure, in which the ignition is accomplished by the production of an electric spark. The mechanism is, perhaps, a little complicated, but the installation is very simple, since it necessitates the use of but a single wire and of ordinary call bell buttons placed at the different points from which it is desired to operate. The same button serves for both lighting and extinguishing, while only five or six battery cells connected in series are required to furnish the requisite current. The apparatus consists of an electromagnet, *E*, arranged upon a flange that surrounds the base of the gas burner, *B*. One of the extremities of the wire of this magnet is connected with the insulated terminal, *H*, of the body of the apparatus, while the other passes into a rubber tube, *T*, and ends at a copper rod, *C*, insulated from the body by means of a sheet of mica. The wire coming from the positive pole of the battery is attached directly to the terminal, *H*, while the negative is connected with any point of the gas pipe, or even with the ground. As the apparatus is screwed to this pipe, all its pieces, save the insulated parts, represent the negative pole. All that is necessary to close the circuit, therefore, is that the end of the rod, *C*, touch some part of the uninsulated apparatus connected with the gas pipe.

Such contact takes place at *A*, at the extremity of a small hooked rod, the lower end of which, *D*, is connected with a spring, *R*, that tends to pull it downward, and consequently to cause it to touch *C*. The current passes into the electromagnet, and the armature, *N*, mounted upon a pivot, *P*, is immediately attracted. Its extremity touches the spring, *R*, and raises it as well as the hook, A, which then leaves the point, *C*. The current is thus broken, but is immediately reëstablished in the same manner as this is accomplished on the hammer rod of an electric call bell.

The spark formed at *AC*, is sufficient to light the gas that escapes at *B*. But, of course, before any gas can escape it is necessary that the cock shall have previously been opened. This operation is performed automatically as follows: The cock is placed at *F*, and a small cross-piece, *M*, that oscillates on the pivot, *L*, opens or closes it according to the position that it occupies. This cross-piece is controlled by a small link, *M*, suspended at the extremity of a lever formed by the armature, *O*, which is placed beneath the first armature, *N*, and has one end pivoted at *P*. A small brass ball tends to keep this armature constantly raised; but, as soon as the current passes, it is the first to be attracted. The magnet draws it so strongly as to overcome the weight of the brass ball and move the end of the lever far enough to open the valve. The motion of the lever is transmitted by means of the connecting link to one end of the cross-piece, *M*, and causes the latter to revolve on its axis, *L*, a sufficient distance to open the valve. By the time the cross-piece has assumed this position, the circuit is broken for the first time at *AC*, and the making and breaking of the circuit continues so rapidly at this point, that there is very little motion to the armature, *O*. What little there is, is taken up by the loop connection of the link with the lever arm. As soon as the gas lights and the operator ceases to press the button, the lever arm, *O*, is raised again to its original position by the brass ball counterweight. This upward motion would close the valve were it not for a small shifting spring that is shown coiled about the link in the illustration. This spring, as the link is jerked upward, automatically shifts it to the other end of the cross-piece, which is now uppermost. The result of this is, that when the button is pressed a second time, and the armature, *O*, again attracted, the link pushes down the opposite side of the cross-piece from what it did at first, and closes the valve. The ascending end of the cross-piece engages a suitable stop so placed as to keep the armature, *O* and *N*, from being attracted enough for the latter to raise the rod, *A*, and break the circuit. Consequently, the valve is closed, and no sparks are produced. When the armature, *O*, once more assumes its normal position, the shifting spring moves the link across to the other end of the cross-piece, where it is once more in position to open the valve.

To sum up, then: at the first emission of a current or pressure upon the button, the cock is opened, and a spark is produced by the circuit breaker that effects the ignition of the gas; at a second pressure, the cock is closed without the production of any spark.

In this second operation, the spark might have been allowed to occur; but that would have been entirely useless. Since the circuit breaker is set in motion, the first time only, the buzzing noise that it produces will be heard only when the valve is opened. Therefore, if for some cause or other, the gas fails to ignite, and a person gives up after a certain number of pressures upon the button, he will be able to tell by the sound, when he starts to go, whether he has left the cock open or closed. Upon ceasing to press the button the second time, the position of the valve will always be known, even if the ignition has not been effected.

The mechanism of this apparatus is certainly somewhat delicate, but it is very well constructed, and is capable of operating for a long time without getting out of order.—La Nature.

THE GOLD DEPOSITS OF CAPE NOME.

By CHARLES G. YALE, Statistician, U. S. Mint, San Francisco.

THE auriferous "black sands" of the ocean beaches along the coast of California have been more or less mined since the year 1850. These auriferous sands occur near Lompoc, Santa Barbara County, and thence extend north of different points to the northern end of the State. The principal seat of this class of mining is in Humboldt and Del Norte Counties, especially near Upper and Lower Gold Bluffs, Humboldt County, and at Crescent City, Del Norte County. Favorable beaches for this work are found at several points. The black sand is abundant, but is not always

ELECTRIC GAS IGNITER AND EXTINGUISHER.

"pay" sand. In fact it is only at few points along the coast where the sand is sufficiently concentrated to pay fair wages to the men engaged in mining. This concentration is effected by the "panning" action of the surf along the beach. The breakers undermine the bluffs, etc., and disintegrate the masses which fall and finally their action concentrates the magnetic iron sands in thin layers carrying sufficient gold to pay for working. In some cases, notably at Gold Bluff, the black sand deposit extends back a mile or more from the beach proper and is covered with ordinary sand dunes. No method has yet been devised to economically work these buried black sands since they are difficult to get at. Drifts run through the lowest stratum, where the black sand lies, are difficult to keep open, as when the sand dries, it sifts through the lagging, etc., and quickly fills the excavations. It is usually the case, therefore, that when black sands are worked, it is done on the open beaches.

In some seasons the beaches pay better than in others. Certain storms which throw the surf diagonally along the beach seem to perform a better concentrating action than when the surf is thrown at right angles to the line of beach. If the black sand is not well concentrated, there is too much ordinary white sand mixed with it for the miners to successfully handle it.

About 72 per cent. of these black sands is magnetic iron and it settles and compacts in a very troublesome way, a great deal of water being required to move it through the sluices. The gold, too, is very fine and thin, the different scales being exceedingly light so that there is very little difference in gravity between it and the iron particles when the size of the pieces is considerd. For this reason it is difficult to save the gold, moreover the quantity of gold per ton of black sand is usually much less than people suppose. From 75 cents to $1.50 per ton is about the average, though richer spots are frequently found. Sometimes the beaches are unworked for a year or more and then found to pay again. In other places the same beach has been worked every season for the past forty or fifty years. These are all secondary deposits on these beaches the gold having originated in the quartz veins and gravels of the adjacent drainage basin back of or near the beaches. At nearly all the mouths of the Northern California rivers are deposits of this gold-bearing sand.

It is generally thought that all beach sand gold is of great fineness as to value. But the fact is the fineness varies greatly even in localities not far apart. For example in the County of Humboldt, on the northern coast of California, on one beach the gold is only 600 fine, or $12.40 per ounce; on another it is 822½ fine or $17.00 per ouuce, and at the largest mine or deposit, the gold runs 934 fine, or $19.30 per ounce. All three of these beaches are in the same county and not far distant from one another.

Of late increased attention has been called to beach-sand mining by reason of the remarkable finds on the ocean beach at Cape Nome, Alaska.

But beach-sand mining is by no means a new thing in Alaska. At Lituya and Yakutat Bays, Southeastern Alaska, this kind of mining has been carried on for some years and has been particularly successful at Lituya Bay. At that place the ruby sand deposits lie along the shore some miles distant above the entrance to the bay. The gold deposited along the shores has, doubtless, been brought by glacial action from the range back of the bay. These are the same kind of "ruby" as those on the beach at Cape Nome concerning which there is now so much excitement. The gold on the Nome beach, is however, much coarser and much more abundant than upon any beaches yet found in Alaska or elsewhere. The deposits in which it is found are the same as elsewhere in Alaska. The sands are called "ruby" sand because they are largely made up of minute rubies and also carry topazes and garnets, all very small and almost microscopic in size. It is in this concentrated ruby sand that the gold is found. It should be borne in mind, however, that this ruby sand does not carry much gold unless there is also present the ordinary "black," or, magnetic iron sand, the same as on the California beaches. The gold on the Nome beach differs from that of all other beaches in California and Alaska in that it is coarse, and heavy, and good sized nuggets are not rare.

There seems to be no reason to doubt the fact that this Nome gold was transported to its present situation by glacial action. It is more or less angular and does not seem to have been much water-worn as in ordinary placers. The same may be said of the gold found in the tundra back of the Nome beach, and many pieces are found with the quartz still clinging to them. The terminus of the glaciers was the ocean where they became disintegrated and gave up their burdens of stone, gravel, gold, etc. On the Nome tundra the presence of gold is not confined to the beds of waterways, but it is found all over the district, being naturally, however, concentrated in larger quantity in the creek-beds, where moving water has gathered it.

The gold deposits of Nome extend back some miles from the ocean beach but how far they extend beyond it has yet to be proven. The theory is that the gold deposits extend indefinitely out into the ocean-bed beyond the shore line and its presence has been proven some hundreds of yards outside the beach line. A number of different forms of dredging apparatus are to be tried at Nome this coming season to gather this gold supposed to lie on the ocean bottom outside the surf line. The result of this class of work in the open sea are problematical to say the least, and it is probable there will be more disappointment than success. The swell of the ocean is such in that locality that dredging operations will be difficult to carry on with ordinary machines and many of the devices to be put in operation are experimental in character in any event, built by men with no experience in that direction. In fact ocean dredging for gold outside a surf line near a beach is in every way an experiment only. Naturally there are many enthusiasts who believe immense fortunes may be made in a few weeks at small expense. It is a noteworthy fact, however, that a dredger put into operation outside the surf at Nome in 1899, only worked a few days and was then taken into the estuary out of reach of the waves and has since been idle. This does not augur well for dredging operations in the ocean at Nome.

The auriferous beach at Nome extends for about forty miles, but the deposits gradually become poorer in gold contents out toward the westward, the richest places being in front of the town, facing the richest tundra deposits ashore. From the beach the tundra deposits combined there was recovered by the miners during 1899—the first season of the new camp—the sum of $2,400,000 in gold. This year there should be a very large increase since thousands of miners will be at work and the claims will be better equipped for work.

Thus far the ordinary rocker has been mainly used for working the beach sands. It is difficult to get sufficient water and "fall" for sluices which have greater capacity than the rockers.

Taking the beach sand in bulk as it comes, if it could all be worked it would probably pay. A number of tons shipped to San Francisco in the fall of 1899 returned at the smelter $40.60 per ton. Of course this might have been the result of a rich spot, since it is far beyond what ordinary beach sands heretofore discoved would pay.

Some hundreds of devices have been tried on the California beaches but the miners finally settled on the ordinary "California Tom," or its better counterpart, the "Oregon Tom." The latter handles about 200 tons of sand in twenty-four hours, and without any power device. The sand is carried into a hopper, whence it falls on to a "grizzly," or screen, where water separates the gravel and sand. The sifted sand falls on a table, which gradually widens to 5 feet, where there is a drop of 4 inches, and the lower part of the table is divided by a central rib into two parts, each 2 feet wide. At the lower end of the table the material drops 8 inches on an iron plate set on a reverse grade and perforated with ¼-inch holes. The fine sand passes through the perforations into two gold-savers, while the coarse sand is raked to one side. These gold-savers are each 25 feet long, 2 feet wide, and have 4-inch sides. The bottom is made of a single 2-inch plank roughened with scratches like those made by a badly-set circular saw. This machine is figured and described in the thirteenth report of the State Mineralogist of California, and seems to be the most successful yet devised for its purpose. It is not patented.

At Lituya Bay, where water for sluicing is obtained, peculiar riffle boxes have been successfully adopted. The Barling beach gold separator has been used at Lituya and is in use at Nome. The Drake amalgamator for beach sands, a power machine, has also been put in highly successful use.

It is worthy of note that in all these sands more or

less platinum is found, associated with iridium and osmium, all valuable by-products, which, however, are seldom saved by the miners.

PRACTICAL CONDITIONS IN THE APPLICATION OF GREEN MANURES.

THE vegetables that are cultivated for the purpose of burying them as enriching material ought to have deep roots and abundant leafage in order to utilize the soil and the atmosphere to the utmost, and to produce in a short time a considerable vegetable mass. Green manures ought to be selected from the family of leguminous plants on account of their valuable property of directly absorbing nitrogen from the air.

The seed should not be costly, for it is evident that the production must be inexpensive. Vegetables should be chosen which can, without difficulty, be buried in the soil, being turned in by the plow. Trailing plants would be inconvenient.

Green manures are divided into two natural groups: Those which are sowed in autumn, to be buried in the spring; those which are sowed in the spring or summer to be buried in the autumn. In the first category are the winter bean, the winter vetch, the red clover, the white lupin, which are sowed in September or October, and buried from March to May according to climate, soil, and the year, for the enrichment of weeded plants. In the second category are the yellow lupin, the white lupin, the spring bean, and the spring vetch, which serve for the alimentation of winter cereals.

The plants should be accommodated to the nature of the soil; thus the beans are adapted to clayey lands; the lupins to silicious lands; the clovers to calcareous lands. The climate must also be taken into account; the lupins, for example, are effected by the cold, and better suited to a moderate climate.

It is an error to suppose that a green manure does not need to be enriched itself; it will give better results and be employed more economically if attended with the best conditions. Of these conditions the fertility of the soil is the most important. The selection being from leguminous plants exclusively, nitrogenous applications can be dispensed with. But a mineral manure is admirably suited, formed, for example, from

Superphosphate	300	kilos per hectare.
Potassium chloride	100	" " "
Plaster	300	" " "

The product should not be left to maturity for two reasons: First, because the decomposition of green plants in the soil is incomparably more active than that of dry and woody vegetables; and the burying ought to take place at the time of flowering, because then the development of organic matter is the most abundant.

There are two ways of burying the product: either to pass a heavy roller over it, which lays it flat; then a plow furnished with a cutter which buries it; or else to use a scythe previously, spread product over the ground, and work with a plow without a coulter, the workman being accompanied by a woman, who brings the material into the furrow. The second process, which is the most costly, is the best. After the burying, done as long as possible before sowing, it is important to roll the soil thoroughly.

The application of green manures to the vine is practiced in certain regions under the conditions we have stated; but its proper cultivation should not be interferred with by this intermediary vegetation, which must be usually dispensed with for the vine, especially as it is considered promotive of cryptogamic maladies.

It is especially on lands not readily accessible, distant from the farm, and on steep hill sides, that we think green manuring is calculated to render the best service.—Translated from Le Phosphate.

SPECIFIC GRAVITY OF THE HUMAN BODY.

By JOHN C PACKARD.

THE work done by the Science Committee of the Brookline Educational Society during the past year is interesting. It represents, rather, a very modest attempt to bring to a head certain projects already under way. The results are as follows:

1. EXPERIMENTS UPON SPECIFIC GRAVITY OF THE HUMAN BODY.

(Conducted at the Brookline Natatorium.)

Whole No. of cases examined		35.	
Age, 14-18 years	Average	16·6	years.
Weight, 88-141 pounds	"	123·6	pounds.
Height, 4'9-5'9	"	5'52	feet.

APPARENT WEIGHT UNDER WATER.

Body entirely submerged, lungs deflated, 1-8 pounds	Average	3·04	pounds.
Body partially submerged nose out, head back, lungs inflated, 0-6 pounds	"	1·3	"
Lungs deflate, 3-10 pounds	"	6·33	"
Body partially submerged, nose and arms out, lungs inflated, 6-13 pounds	"	8·9	"
Lungs deflated, 10-19 pounds	"	13·6	"
Body partially submerged, head out, lungs inflated, 4-13 pounds	"	8·3	"
Lungs deflated, 9-16 pounds	"	12·8	"
Bodily partially submerged, head and arms out, lungs inflated, 12-13 pounds	"	17·4	"
Lungs deflated, 18-30 pounds	"	21·3	"
Specific gravity, 1-1·081			1·000.

Temperature of Water 80° F.

The practical lesson to be drawn from the above facts is the oft-repeated one that our boys and girls need to have emphasized again and again; namely, that the amount of effort required to keep a person afloat in the water depends largely upon the proportion of his body that is kept under water. It will be seen that whereas if the nose and mouth only are kept above water, it requires at the most but 10 pounds (average 4 pounds) uplift on the part of a rescuer to keep a person from drowning, if a wild attempt is made to keep the head and arms out, as is too commonly the case with a non-swimmer, the necessary uplift may amount to as much as 21 pounds (average 19·3 pounds).

Austrian Export Efforts.—Vice-Consul-General Hanauer, of Frankfort, says that according to a recent official statement, Austrian experts in economics are to be sent abroad for studying the conditions of transportation, of manufacturing, and of the export trade. These official investigators are to be stationed at Berlin, Munich, Brussels, Bucharest, Odessa, and New York.

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